
Photo: Ann-Marie Jacoby NMFS Permit No. 23782


Photo: Melissa Collier NMFS Permit No. 23782

Characterizing infectious disease risk in a sentinel marine mammal with social behavior data

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Marine mammals are essential for healthy ecosystems and fisheries

Sentinel species

Top predators

Reports of marine mammal disease are increasing

Marine mammals are affected by a variety of disease

Reports of disease in marine mammals has increased in the past 40+ years (Gulland & Hall, 2007; Simeone, et al. 2015)

Climate change thought to intensify deadly pathogens and increase the frequency of mass mortalities (Sanderson & Alexander, 2020)

Case study: Cetacean morbillivirus (CeMV)

- Infects a variety of cetacean populations worldwide
- Respiratory pathogen with high mortality rate in bottlenose dolphins
- 2013-2015 1,650 dolphins died along the Atlantic Coast, USA
- ~40% reduction population

Host Behavior

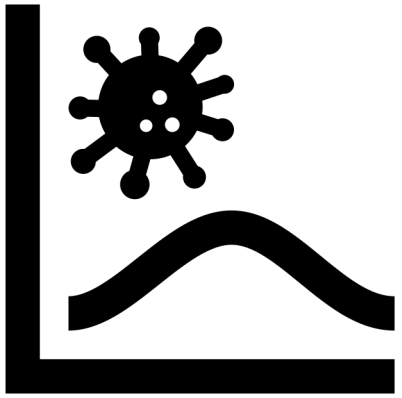
- Social Structure
- Habitat
- Age
- Sex

How might variation in social behavior play a role in bottlenose dolphin vulnerability to CeMV?

Experimental Setup: Model a dolphin contact networks based on empirical data and simulate disease spread

Empirically characterize heterogeneity across individuals using focal follows

Build network model to describe population scale behavior



Predict disease spread in population

Methods: Gather data on “disease related behavior”

Breathing Synchrony

- Affiliative social behavior
- Surfacing and exhaling within 5m and 2 seconds of at least one other individual

Focal Follows

- Individuals classified into 3 demographic groups
  - Adult Female
  - Adult Male
  - Juveniles
  - Ignore calves

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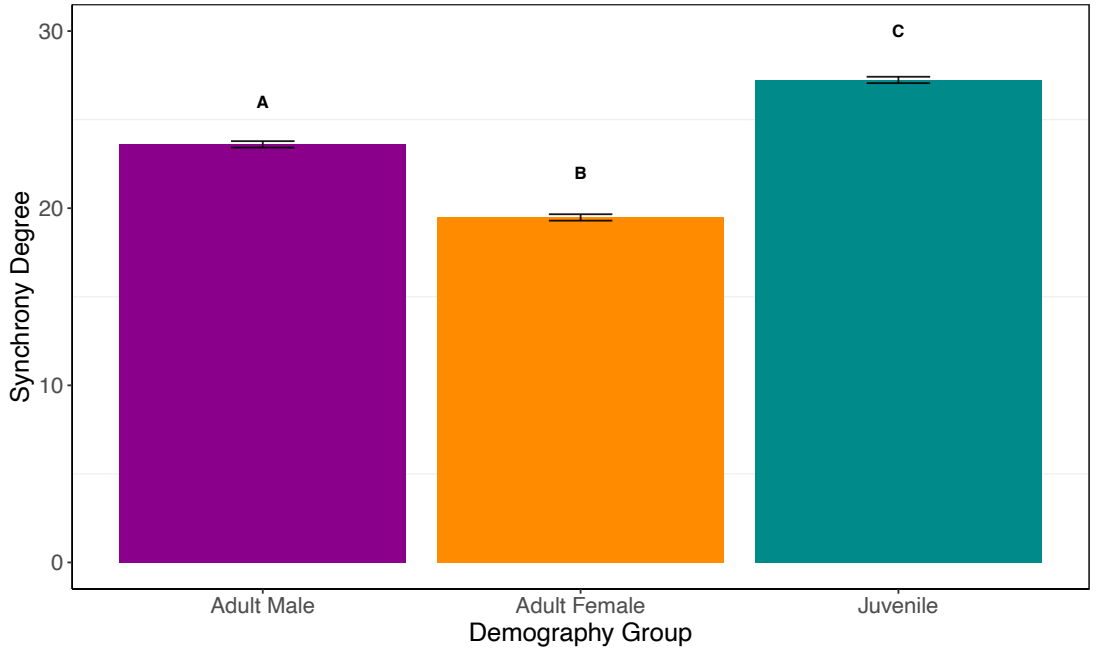
All photos taken under NMFS permit no. 23782

Focal follows reveal differences in contact across demography

- **Average Degree:** Number of contacts over an CeMV infectious period (5-10 days) for each demographic
- Used a series of generalized linear mixed models

Synchrony ~ Demography + Time + Dolphin ID +Year

Collier et al, *In prep*

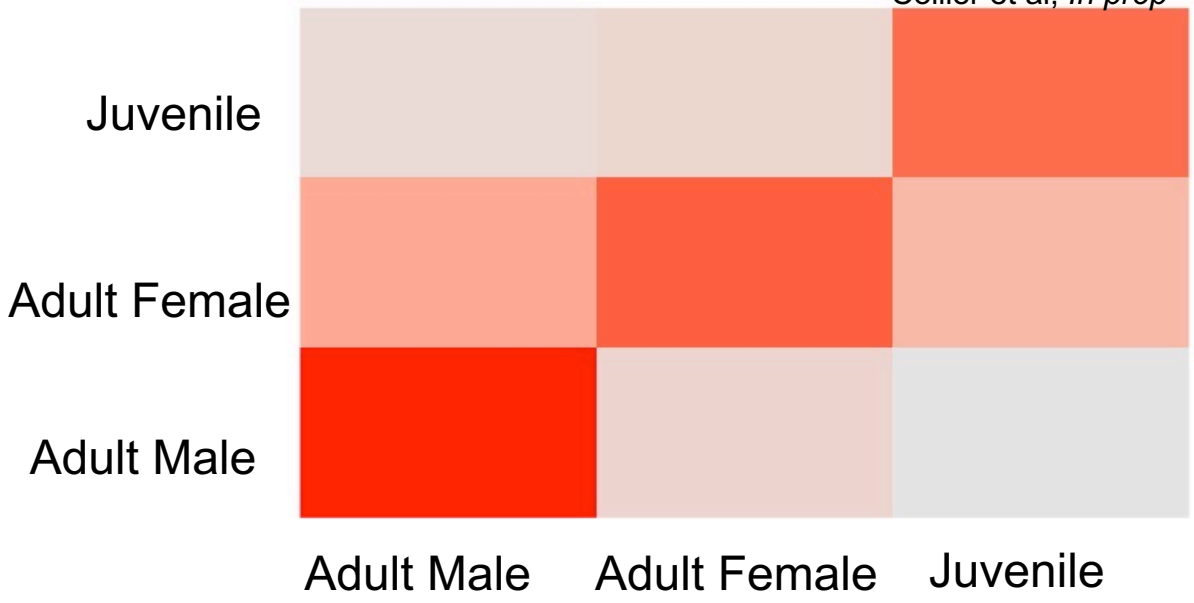


Assortativity: The tendency for individuals to associate with individuals of their own grouping

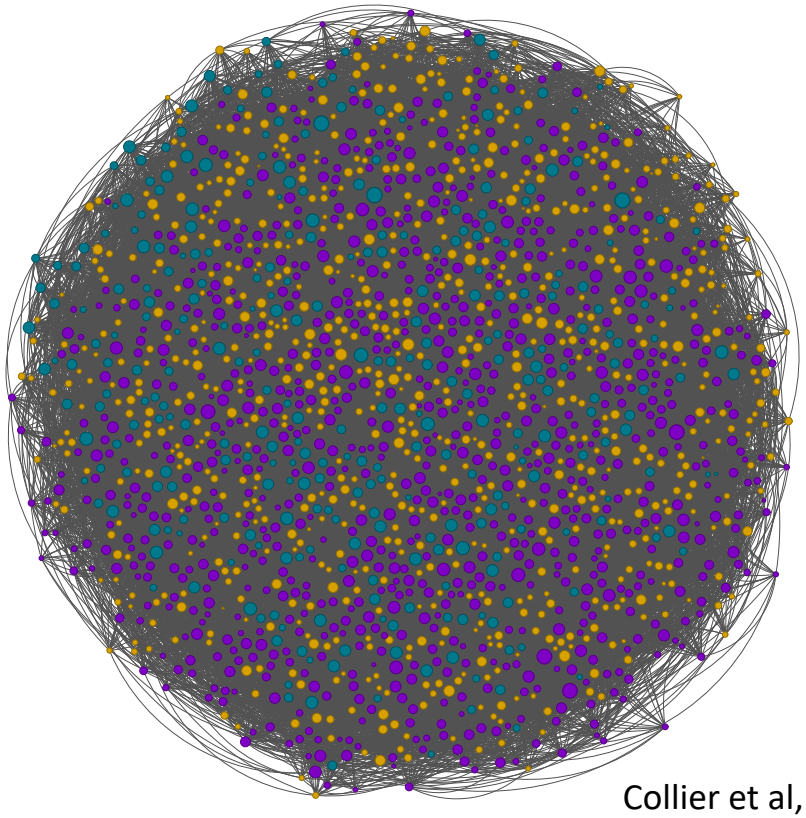
- Generate mixing matrices from focal follows
- Represent the proportion of observed sync pairings that occurred in each demographic pairing

Assortativity = 0.44**

Collier et al, *In prep*



Results: Disease simulations on n=25 simulated networks reveal differences in disease vulnerability across demographics



Collier et al, *In prep*

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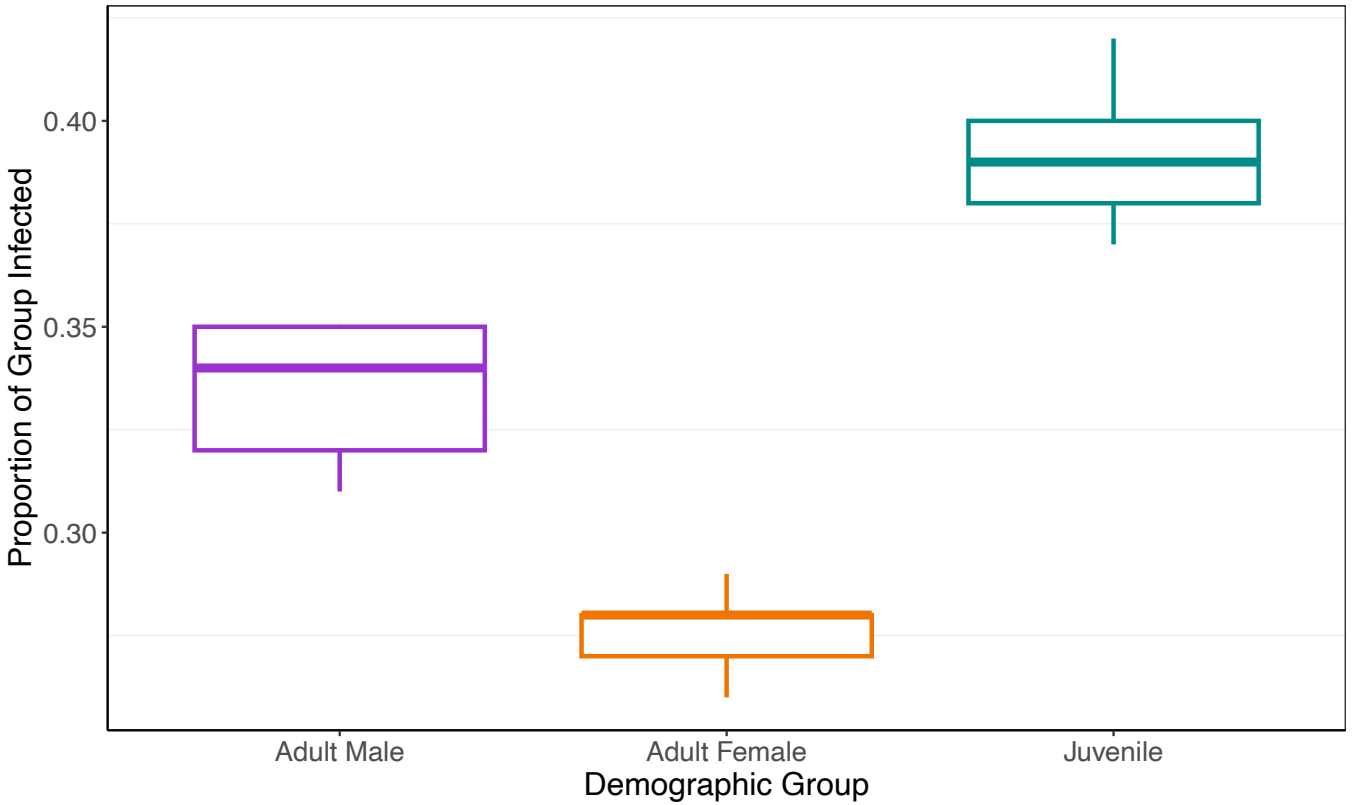
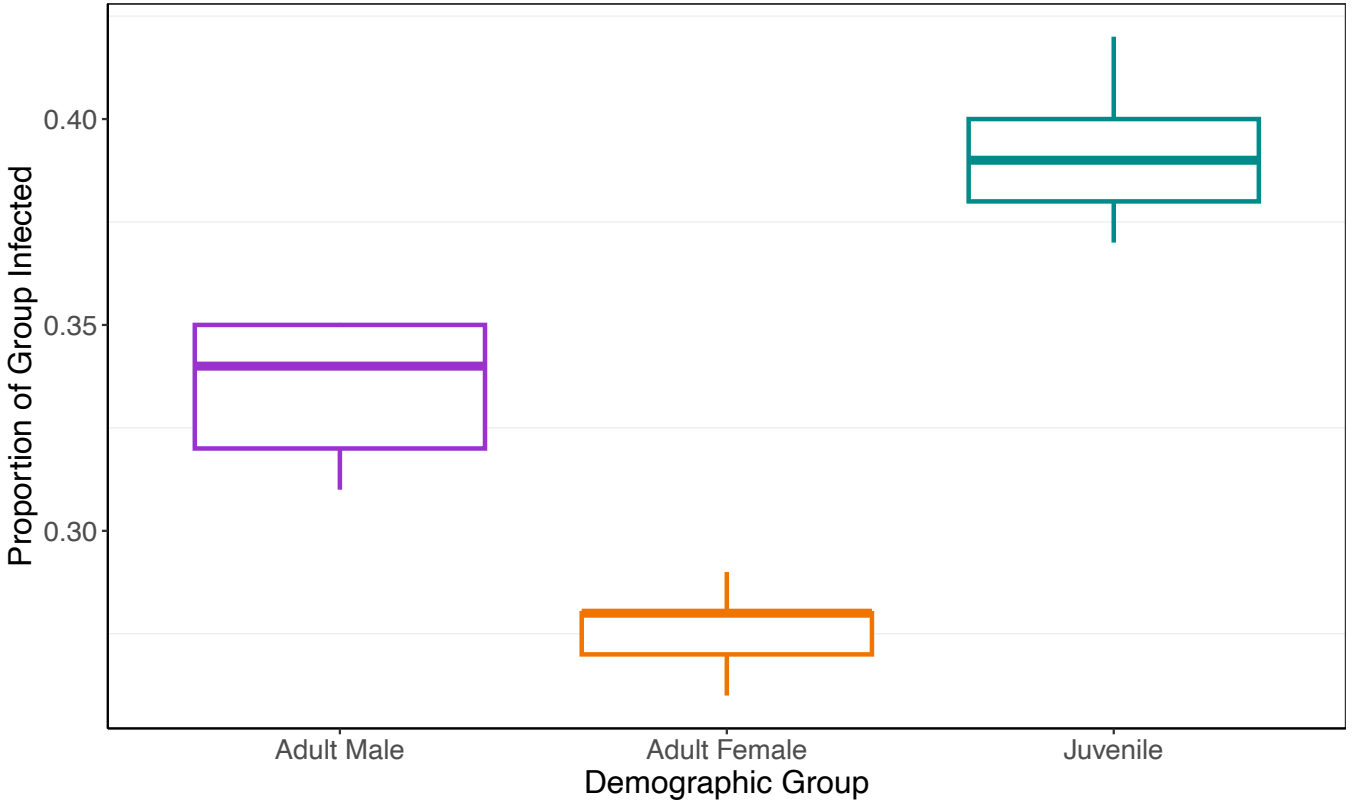
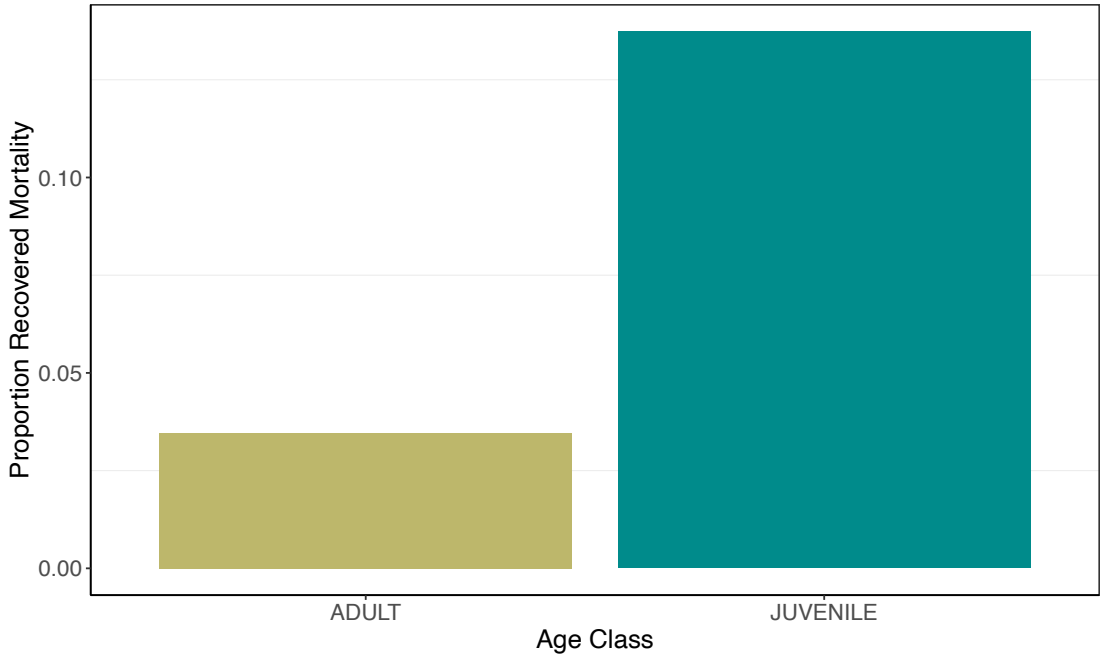


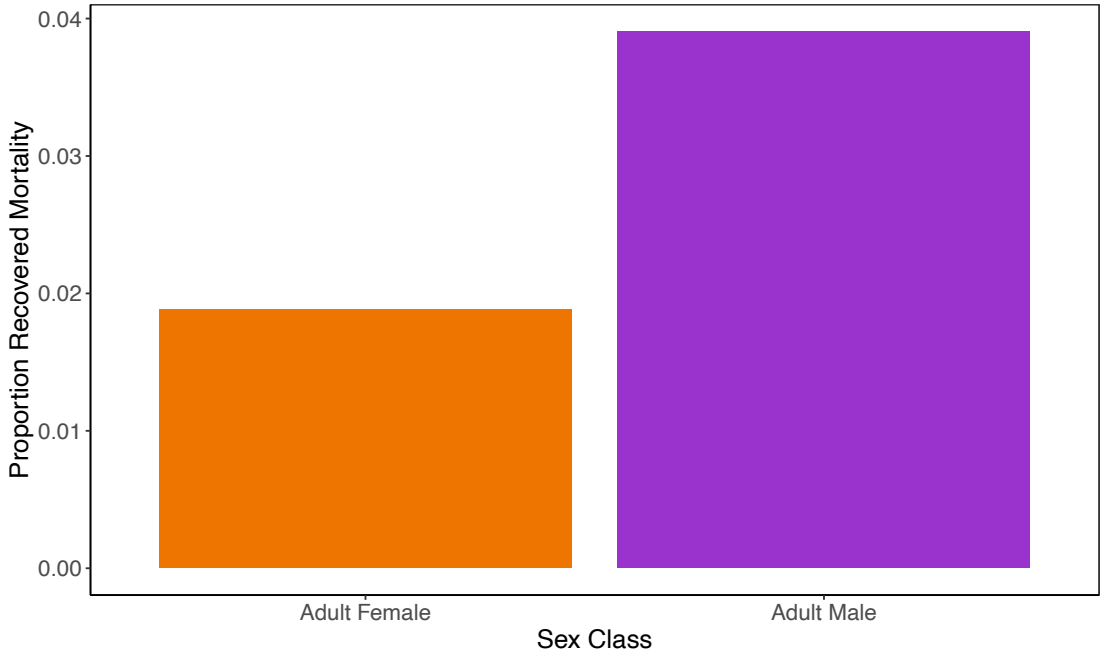
- Adult males infected disproportionately to adult females
- Juveniles infected disproportionately to adults

Simulations reveal similar trends to mortality data

Collier et al, *In prep*

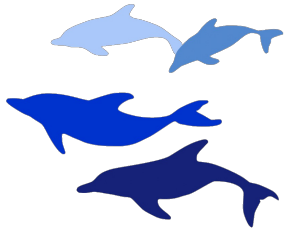






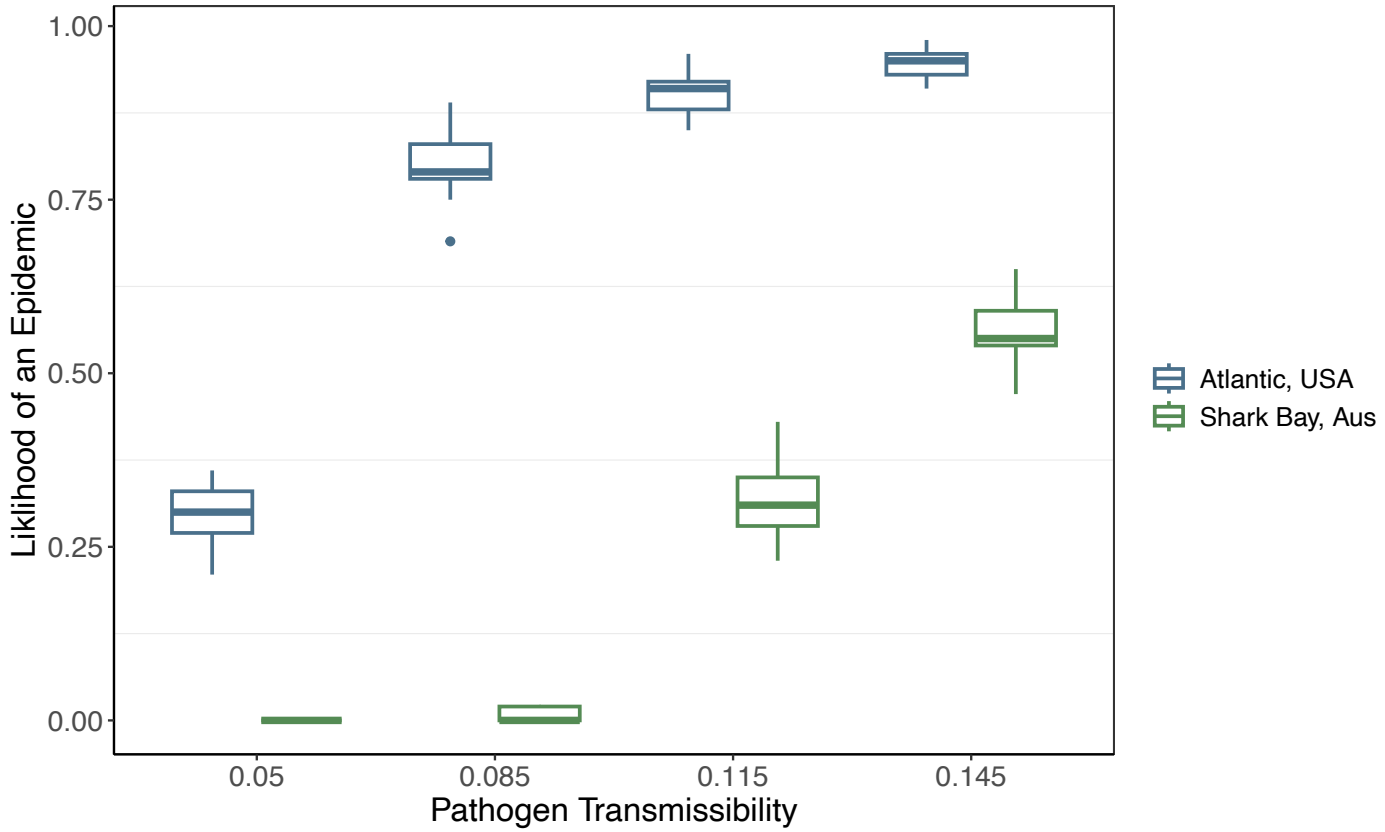
Mortality data courtesy of the National Marine Fisheries Service

Future Directions: Use methodology to compare disease risk across populations



Shark Bay Dolphin Research Project

CeMV is not epidemic in Western Austrailia
Causes periodic mortalties



At varying levels of pathogen transmissibility:

- Epidemics are less likely to occur in the Shark Bay populaiton

Conclusions: Social behavior is an important factor in marine mammal disease vulnerability

Our models suggest:

- Social behavior varies across demographic and population
- Disease vulnerability may be affected by this variation

Our models could explain:

- Disproportionate demographic findings of mortality data
- Lack of epidemics in some parts of the world (e.g. Western Australia)

Our models could help forecast:

- Future epidemic scenarios
- Future population level impacts

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