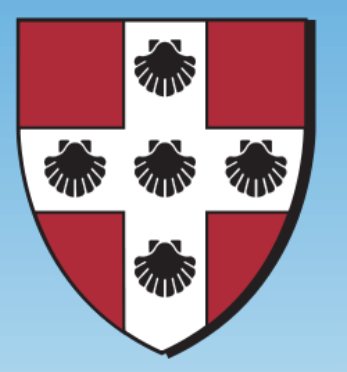# In Hot Water: Increasing Extinction Risk of Marine Species

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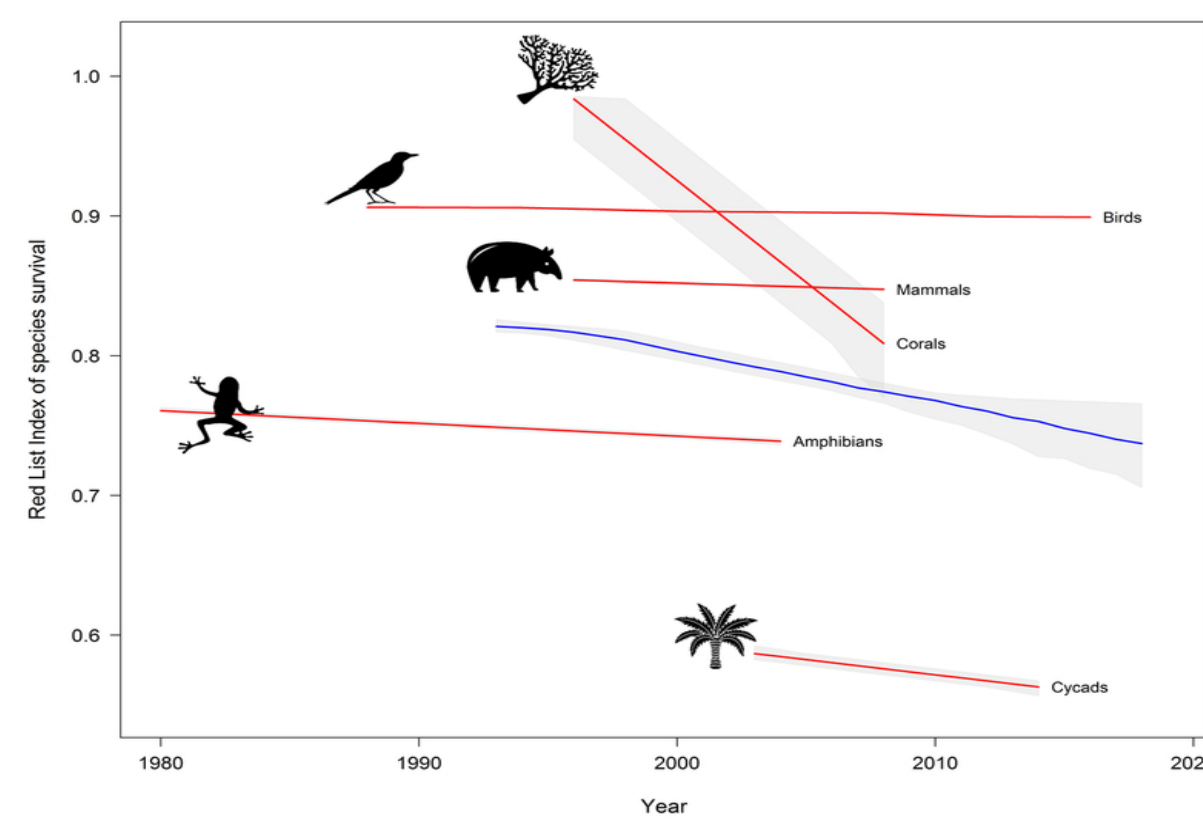
Introduction

Fig. 1 Red List Index (from IUCN) where 1.0 indicates all species are Least Concern and 0 indicates all species are Extinct.

The International Union for Conservation of Nature (IUCN) Red List identifies the extinction risk of species. The Red List Index exposes trends in extinction risk for species based on genuine changes of Red List category. This means changes due to improvements or deteriorations in status rather than the availability of more information. The Red List Index has shown that within the five indexed taxonomic groups, most are creeping towards extinction (Fig. 1, IUCN).
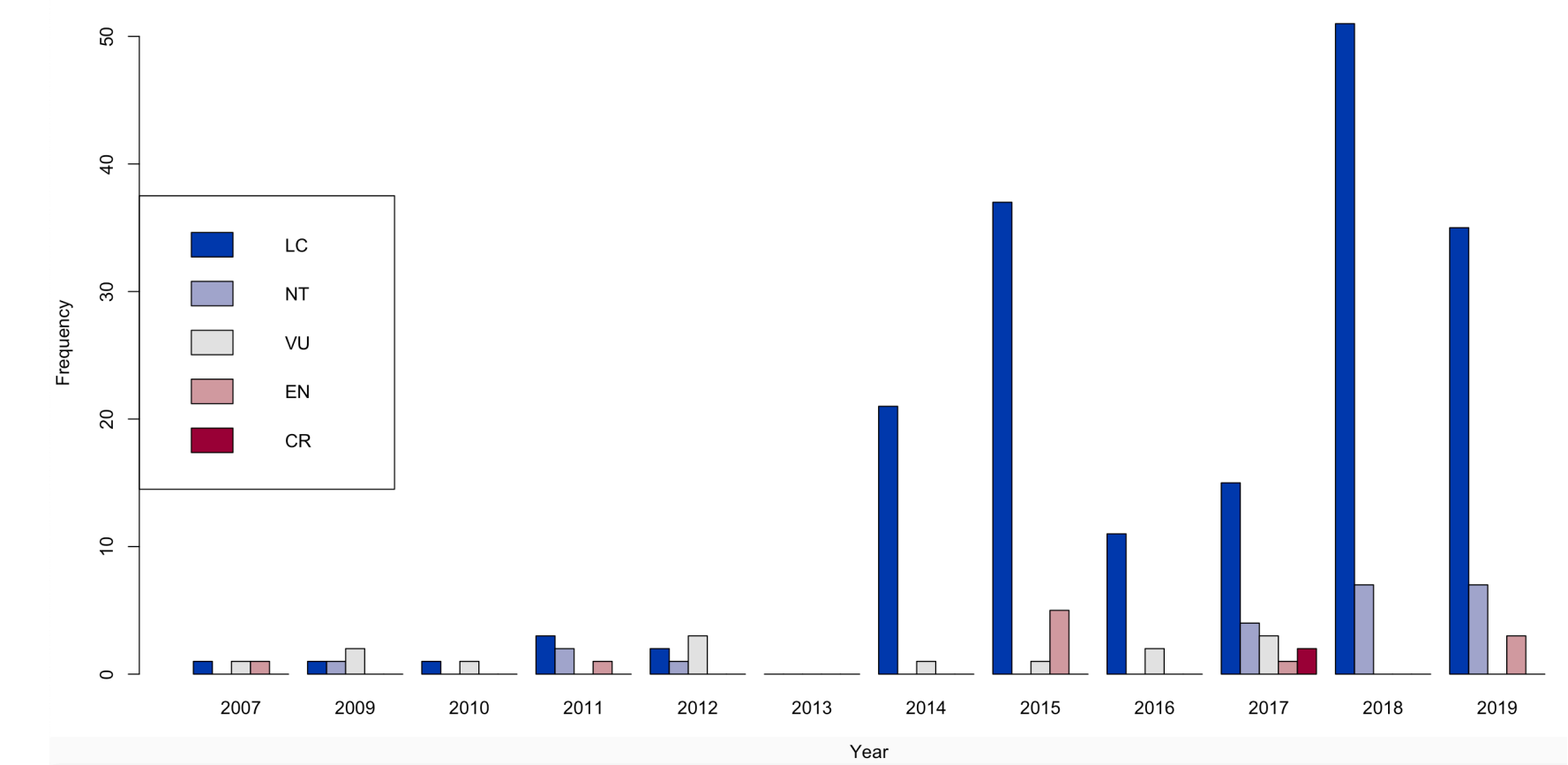
Goal: My goal was to determine both the proportion of Data Deficient marine species that are actually threatened and whether the proportion of threatened marine species has increased in recent years.

Threats to Marine Species

Marine species face intense pressure from threats that will continue to increase in severity as a result of a growing population and demand for fish products, climate change and ineffective prevention of coastal polluting. These threats include:

- Physical damage to coastal habitat and spawning grounds
- Gross overharvesting, misreporting of catch and bycatch mortality
- Chemical pollution (pesticides, sewage, oil, etc.)
- Ocean acidification
- Rising ocean temperatures

Data Deficiency

Threats towards marine species are accompanied by a research gap in marine conservation. There is much we don't know about the population dynamics of marine species and this complicates making predictions about marine populations. Due to the research gap, 23.2% of marine species are categorized as Data Deficient (DD) despite only 10.5% of terrestrial species bearing the DD categorization.

- The IUCN categorizes species that have sufficient data available based on their abundance, population dynamics and geographic range into one of the following categories:
  1. Least Concern (LC)   3. Vulnerable (VU)   5. Critically Endangered (CR)
  2. Near Threatened (NT)   4. Endangered (EN)   6. Extinct (EX)

Methodology

The data used was sourced from a larger IUCN database on species changing Red List status. To form the subset, I extracted all 227 marine species that changed status from DD to any other Red List category in the years 2007-2019. The table available for the year 2008 included only genuine status changes, so I did not include this year in my study. I compared the proportions of new categories in the subset to the set of all 12,494 non-DD marine species listed on the Red List currently. To test whether these proportions were significantly different ($p < .05$), I bootstrapped 10,000 replicates such that I resampled the large dataset of 12,494 non-DD marine species into lists of length 227. I calculated the mean standard deviation from the set of 10,000 bootstrapped samples in order to calculate their 95% confidence intervals. If the value of the actual sample of 227 species fell outside the 95% confidence limits of the bootstrapped samples, then the set of re-categorized species is significantly different than the large database.
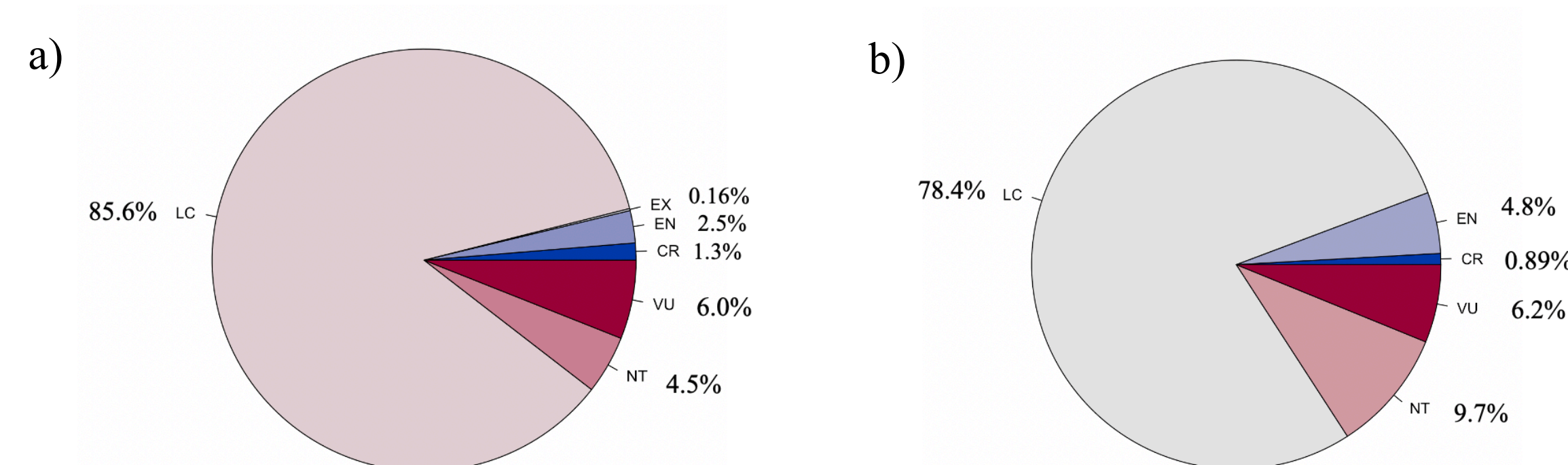
Results

Fig. 2 IUCN categories represented by a) all non-DD marine species and b) the subset of marine species re-categorized from DD in the years 2007, 2009-2019.

- Higher proportion of NT and EN species and a lower proportion of LC and EX species in the re-categorized data set

Results Cont.

Fig. 3 IUCN Re-Categorizations of DD Marine Species

- Sharp increase in number of re-categorized DD marine species in the last six years
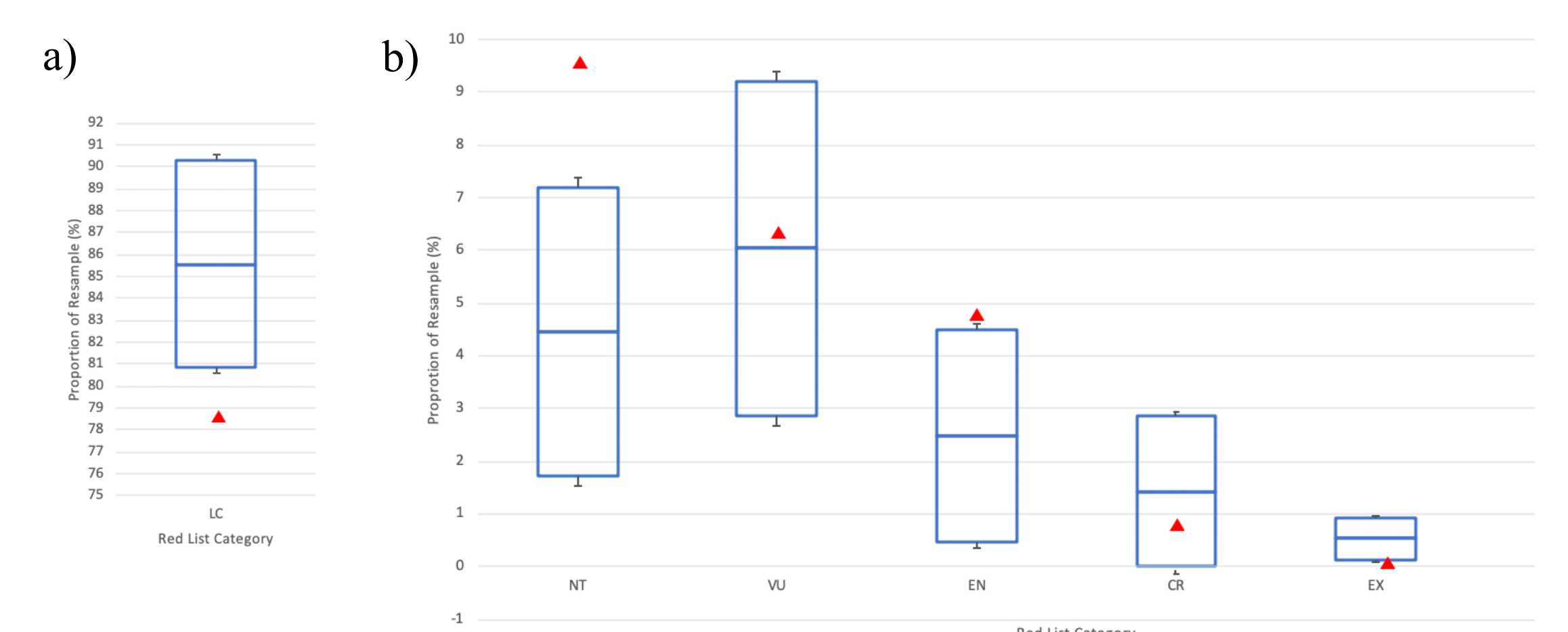

Fig. 4 Results from 10,000 replicate bootstrap resampling of the set of all non-DD marine species. Boxplot shows mean +/- 2 S.D. and +/- 2 S.E. Red triangles signify actual percentage found for the 227 species subset. Note the scale difference between a) LC and b) NT, VU, EN, CR and EX.

- Resampled subset shows a significant increase in the proportion of NT and EN marine species
- Resampled subset also shows a significant decrease in the proportion of LC and EX species

Conclusions

- Since 2007, there has been a significant increase in the proportion of NT and EN marine species
- There has also been a significant decrease in the number of LC and EX species
  - While fewer species listed as EX is ideal, the current overall proportion is still exceptionally small (0.12%)

Conservation Suggestions

- Enactment and enforcement of regional protections, including listing marine species on the U.S. Endangered Species Act
- Maintain more than one governing body over marine species and/or ensure that there are checks on power
- Fewer and/or stricter government subsidies on the fishing of at-risk species

Reducing the Proportion of DD Marine Species

- Petition government funding of research on marine species
- Shrink the current gap between species listed as threatened on the Red List (more) and species listed on the U.S. E.S.A. (fewer)

Future Directions

- Formulate Red List criteria that account for special characteristics of marine species:
  - Overharvested species with reduced access to spawning sites
  - Species described from very few (<5) samples
  - Extreme habitat specialists where host experiences mass mortality events
- Apply predictive modeling to DD marine species in order to estimate their risk of extinction

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