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Status Review Report of 82 Species of Corals Under the U.S. Endangered Species Act

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Highlights

- Specific ecological information on most of the 82 species was limited to non-existent
  - Population status, trends
  - Specific vulnerabilities to various threats
- Many 'ecological threats' have depensatory potential. That is, they may have greater impact as individuals become rare.
  - Allee effects (fertilization)
  - Fewer larvae in circulation ➔ lesser connectivity and recolonization potential
  - Predation (may have greater impacts on rarer species)
- Fishing, sedimentation, water quality/habitat quality, direct disturbances, etc. all are influential and at times acute at local scales, but not the primary sources of extinction risk.

Population info

- *Montastraea annularis* complex (MAC) only species' for which reasonable info available on species abundance/trends across range (but often as a complex)
- Limited information suggesting at least site-specific population declines for
  - *Dichocoenia stokesi* (disease outbreak)
  - *Mycetophyllia ferox* (longer term trend)
- Limited information/estimates on rarity patterns and global population size for several Pacific *Acropora* spp. (Z. Richards)

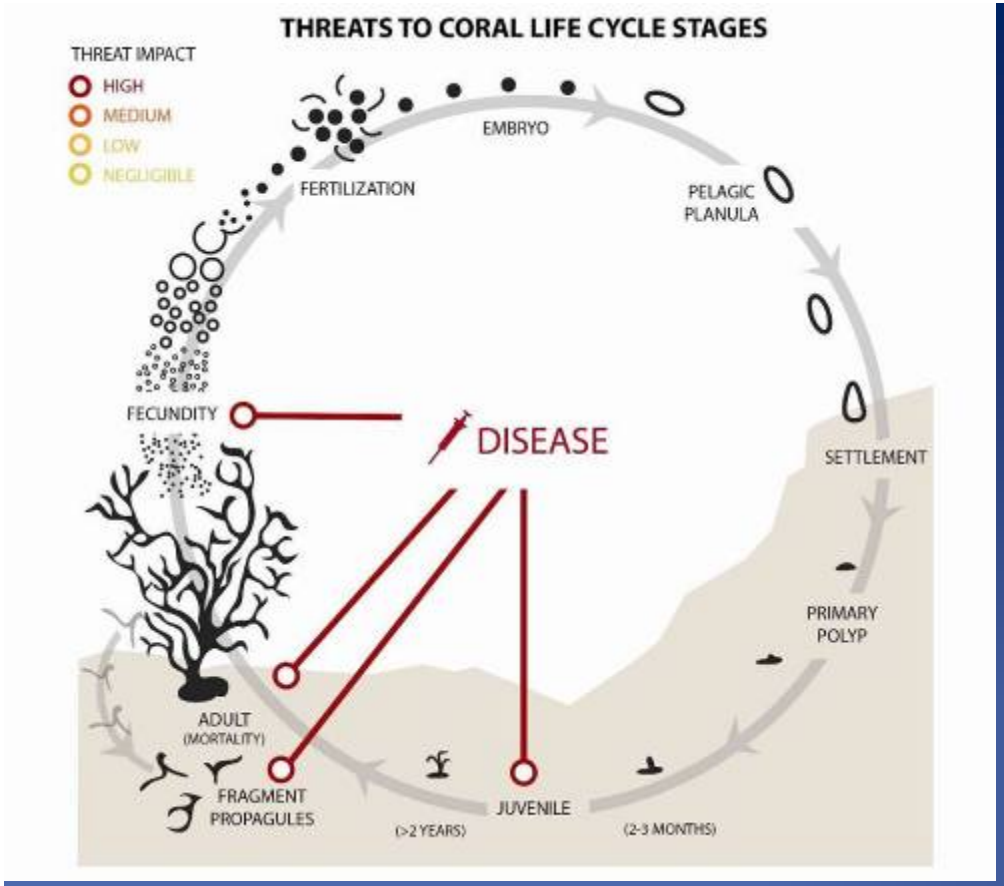
Evaluation of Extinction Threats

Section 4(a)(1) Factors	Threat	Importance
5	Ocean warming	high
3	Disease	high
5	Ocean acidification	med-high
1	Fishing- trophic effects	medium
1, 5	Sea-level rise	low-medium
1	Sedimentation	low-medium
1	Nutrients	low-medium
5	Changing circulation	low
1	Changing storms	low
3	Predation	low
1	Fishing - destructive practices	low
1	Physical damage - storms	low
1	Coastal construction	low
2	Aquarium and curio trade	low
5	Toxins*	not neglibile
5	Invasive species	neglible-low
5	Insolation*	probably negligible
5	Salinity	negligble
5	Dust	negligible
1	Physical damage - debris	negligible
1	Physical damage - tourism/divers	negligible
1	Physical damage - vessels	negligible

- Severity of threat evaluation based on 'status quo' of threat (exposure) or confident expectation of change

  e.g. imminent regulation

- Susceptibility often generalized to genus, family, or corals in general



Disease

Table 3.3.1. (Adapted from Palmer et al 2010).

Family	Immunity Rank	Predominant Growth Form	Extension Rate	Reproductive Output
Acroporidae	Low	Branching	High	Intermediate/High
Pocilloporidae	Low	Branching	High	Intermediate/High
Faviidae	Intermediate/ High	Massive	Intermediate/ Low	Intermediate/High
Mussidae	Intermediate/ High	Massive	Low	Intermediate/High
Fungiidae	High	Solitary	-	High
Poritidae	High	Massive	Low	Low

Disease

- Extensive interaction with other factors
  - Warming/bleaching
  - LBSP/Water Quality
  - Trophic status of reef ecosystem . . .?
  - General connectivity of system
    - Higher impact in smaller, more connected Caribbean basin than most Pacific regions
- High uncertainty regarding potential management or adaptation

'Trophic disruption'

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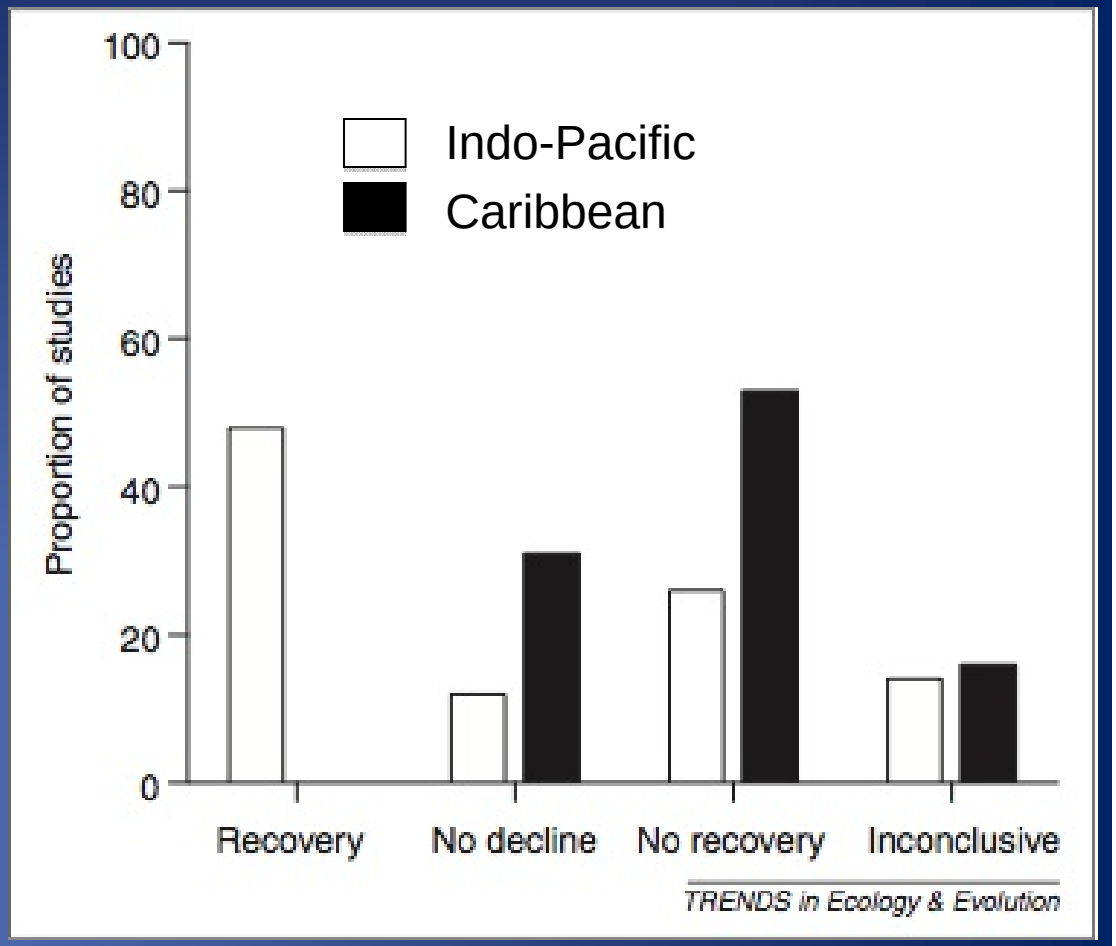
- Host of categorized threats related to general trophic status of the ecosystem
- Direct effect on species AND indirect effects on e.g., habitat

'Caribbean Factor'

- Relatively small, highly oceanographically connected basin (relative to Indo-Pacific)
- Severe disturbance history
  - Pervasive 'local' impacts
  - Basin-wide trophic disruption
  - Pervasive declines from coral bleaching and disease already manifest

- Lower Caribbean resilience due to (Roff & Mumby 2012)
  - Higher macroalgae:coral cover
  - Greater macroalgal growth rates
  - Greater iron enrichment
  - Depauperate Acroporid fauna



Proportion of studies showing recovery from disturbance. 'No decline' means initial disturbance impact was <33% decline relative to initial % coral cover (Roff&Mumby 2012)

Treatment of adaptation/acclimatization:

- Existing geographic adaptation to extreme thermal environments (e.g. Arabian Gulf)
- Hypothetical 'adaptation rates' required for various climate scenarios (e.g. Donner et al 2005)
- Some evidence suggests zoox switching may account for up to 1.5oC increase
  - Probably not adequate for projected 2oC warming, it does significantly prolong extinction time
- Discussed holobiont evolutionary potential, but not adequate knowledge to evaluate well.
- Other 'adaptive responses' such as
  - Range expansion/shift (dependant on effective dispersal and availability of appropriate habitat)

Extinction risk of a 'moving target'?

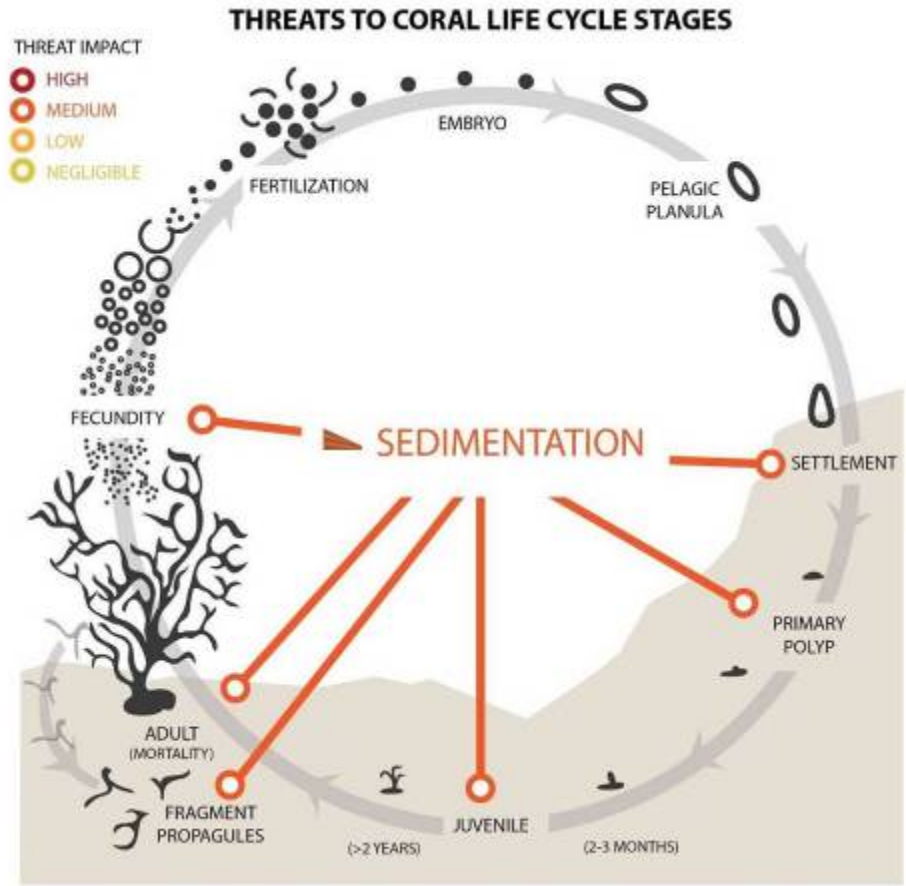
- ESA guidance indicates risk evaluation on current 'status quo' unless there is confident expectation of future change
  - Appropriate scales and rates?
- Dearth of species-sp info on basic life history and vulnerabilities, even greater uncertainty in adaptive response of given species.
- In case of disease/immunity, complex of interacting moving targets. . .

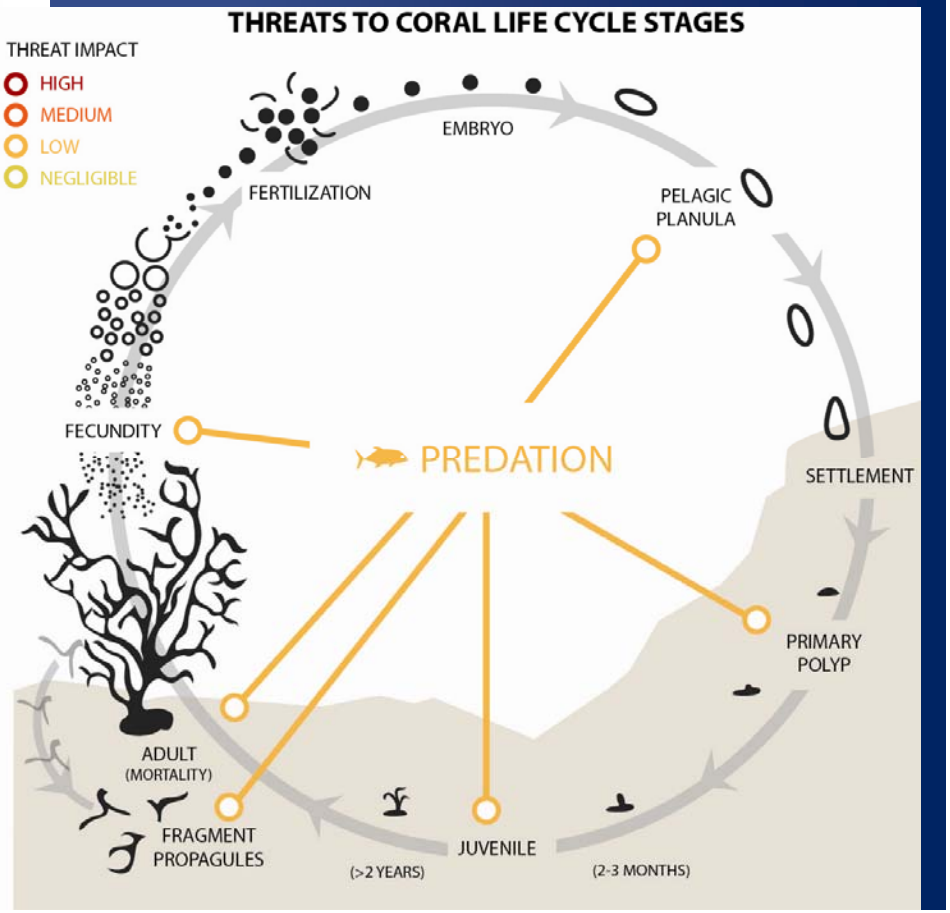
Conclusion

- Very little info on species' current status and vulnerabilities
- Lots of threats that no doubt interact
  - Not adequate info to quantify
  - Caribbean ecosystem appears more vulnerable; translates to higher risk for many Caribbean species
- Not adequate data on future changes in species (adaptation, other adaptive response) to substantially ameliorate risk assessment

Finally, reef-building corals are functional holobionts and there is substantial diversity of the symbiotic zooxanthellae and microbial components. The BRT did not formally address this level of diversity in the species analyses, as it is beyond the scope of the petition. However, the BRT acknowledges that the ability to host, for example, multiple clades of zooxanthellae may provide the ability to adapt to different environmental conditions and addressed this in individual species accounts when relevant information was available. This is clearly a complex issue that remains poorly understood. While genetic variability among zooxanthella has been found across reefs, among reefs, and geographically (Baker et al., 2001; Fabricius et al., 2004; LaJeunesse, 2002; LaJeunesse et al., 2004a; LaJeunesse et al., 2003), the ability (or lack thereof) to either incorporate new zooxanthellae or retain them after stress events may control adaptation (Coffroth et al., 2010; LaJeunesse et al., 2010; LaJeunesse et al., 2009; Thornhill et al., 2006). (p.91)

Threats to Coral Life Cycle Stages





Interactive & Unmeasureable (?)