



ARC Centre of Excellence
Coral Reef Studies

Vulnerability of sea turtles to climate change

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Sea turtles in Australia

**There are seven species of sea turtle in the world
Six of them occur (nest and feed) in Australia**



Green turtle

Ecological role

(maintain healthy seagrass bed, balance food webs)



Flatback turtle
(endemic to Australia)

Cultural significance

(food source and cultural symbol during ceremonies)



Leatherback turtle

Economical importance –Iconic species

(tourism value having turtles on the reefs)



Loggerhead turtle



Olive Ridley



Hawksbill turtle



Depleted populations

- Drastic reductions during last century
- Species of conservation concern
- Depletion increases the vulnerability of populations to additional threats and lowers their ability to adapt to and recover from climate change



Traditional hunting



Boat strike



Illegal trade



Predation by introduced species



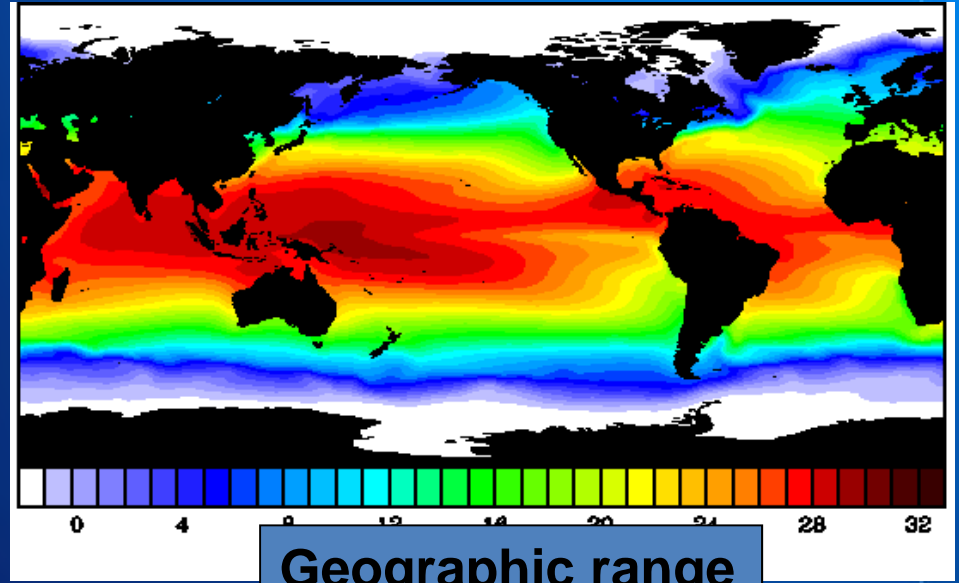
Pollution/ bycatch



Sea turtles and climate change



**Reproductive output
(nesting grounds)**



Geographic range



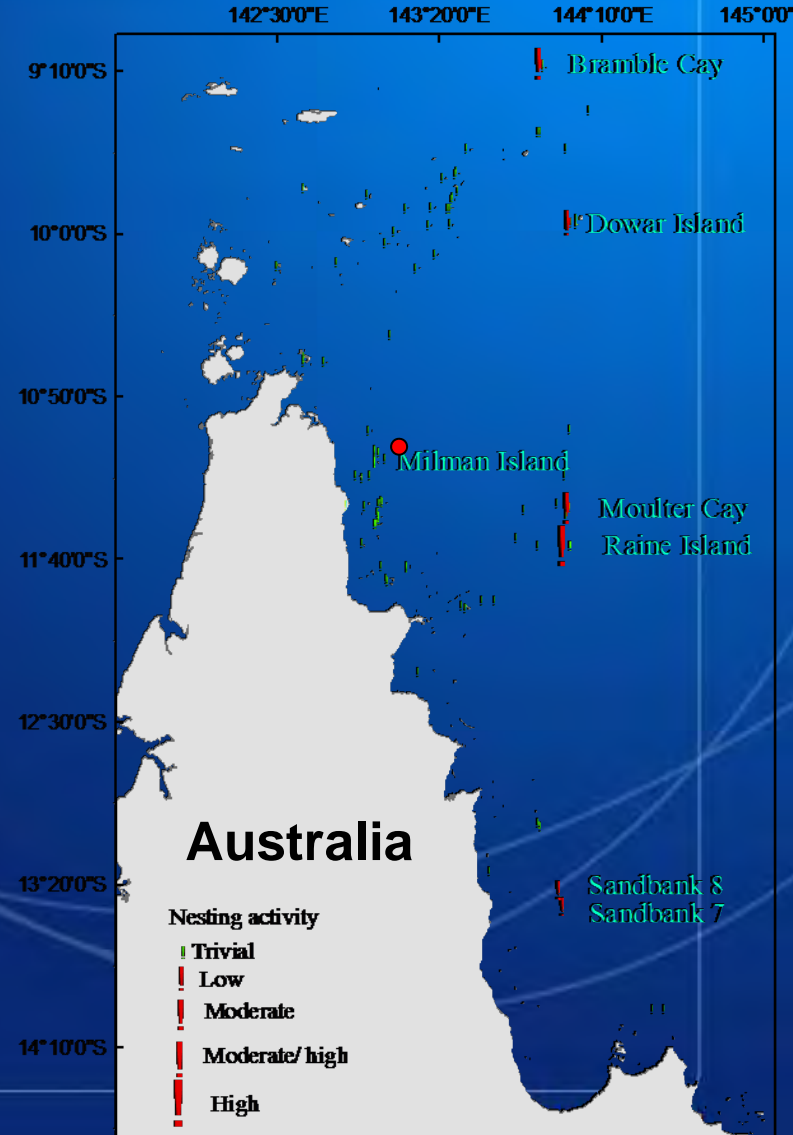
Foraging ecology



Sea turtles and climate change

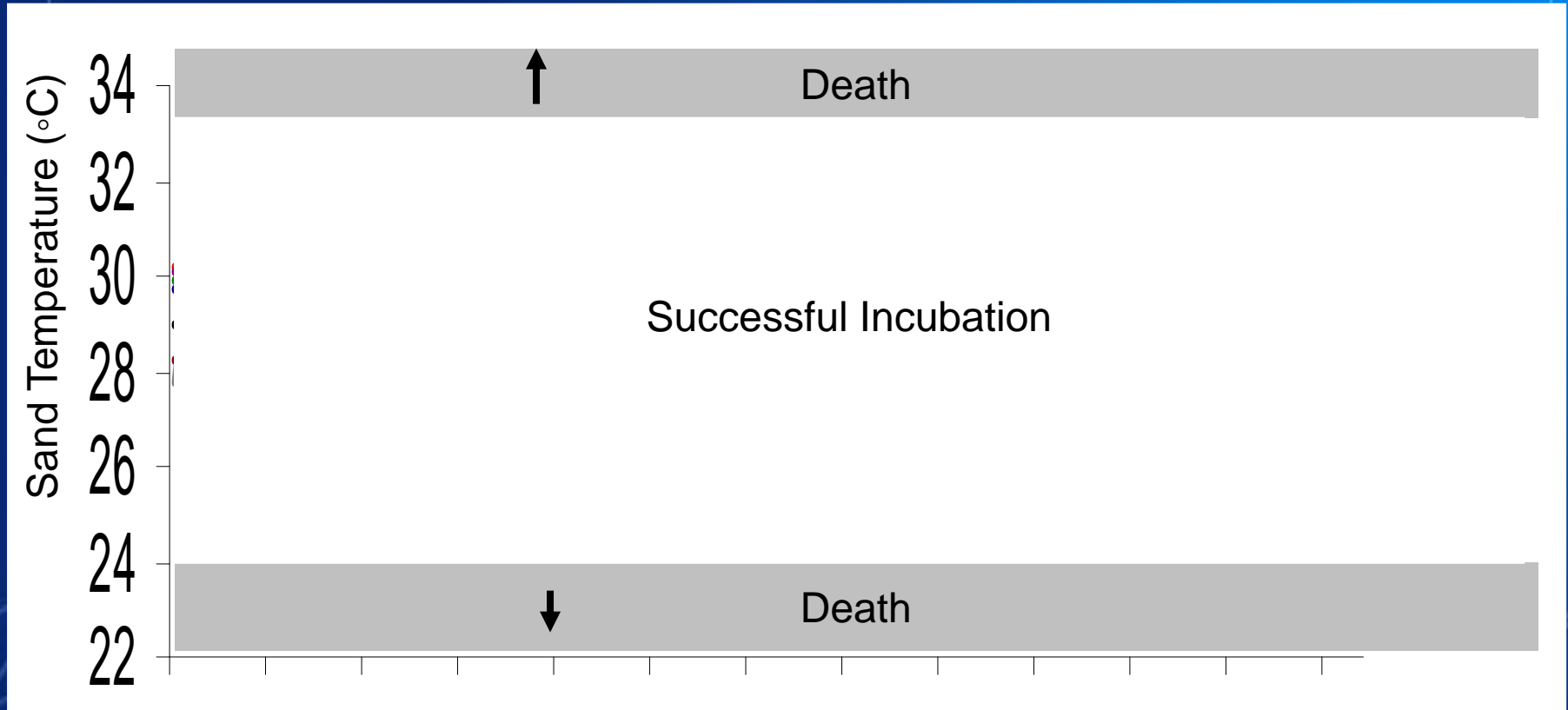


Reproductive output
(nesting grounds)





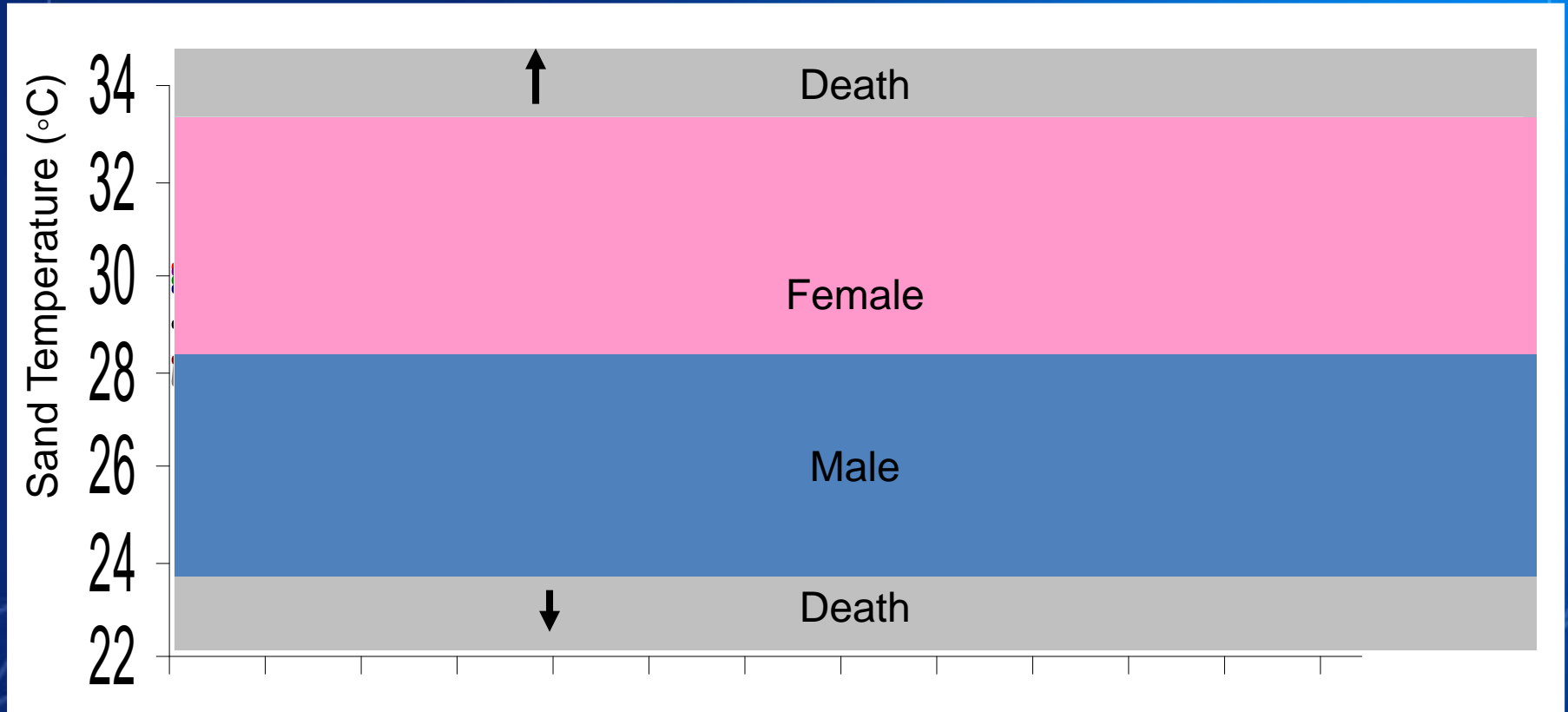
Sea turtles and temperature



- Temperature plays a role on embryo development, hatching success and hatchling sex ratio
- Successful egg incubation (24- 33°C)



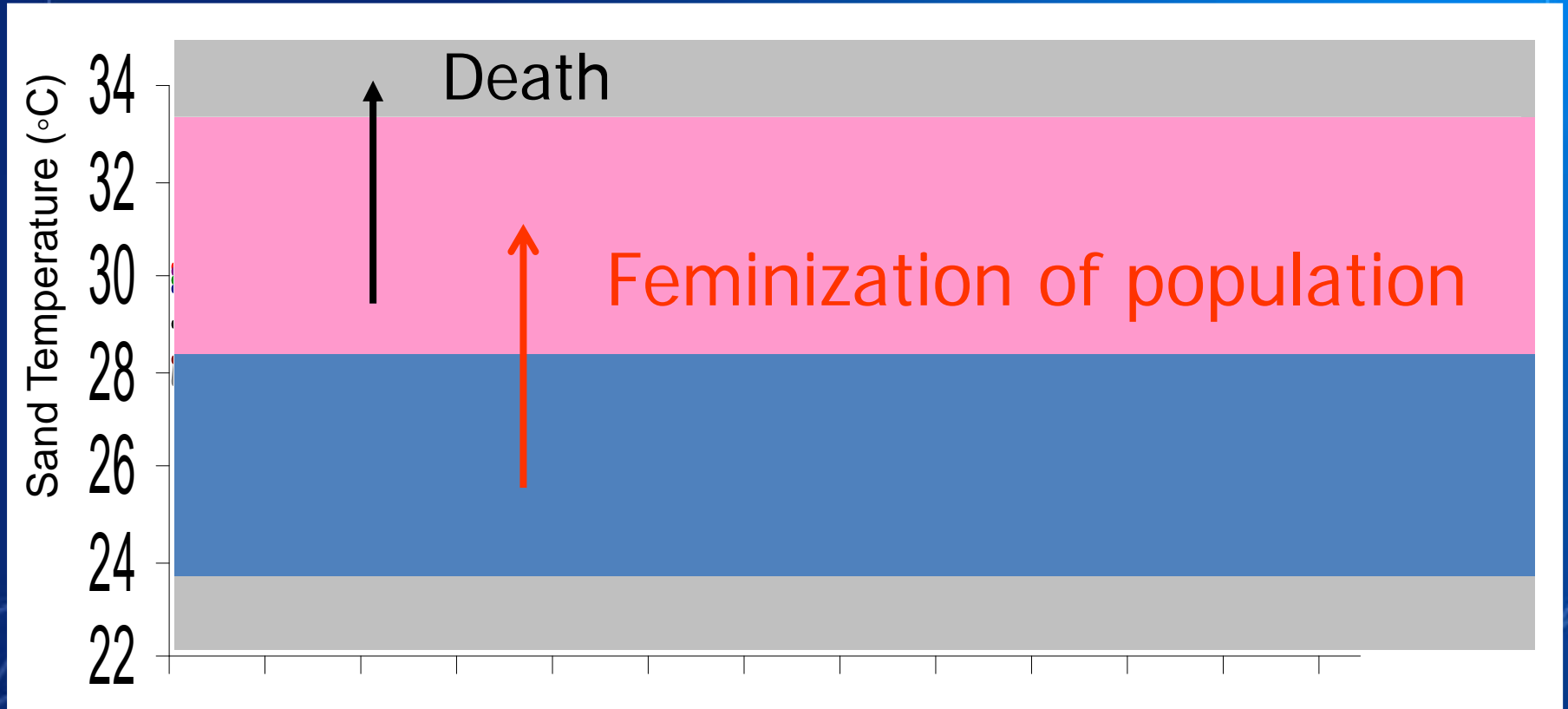
Sea turtles and temperature



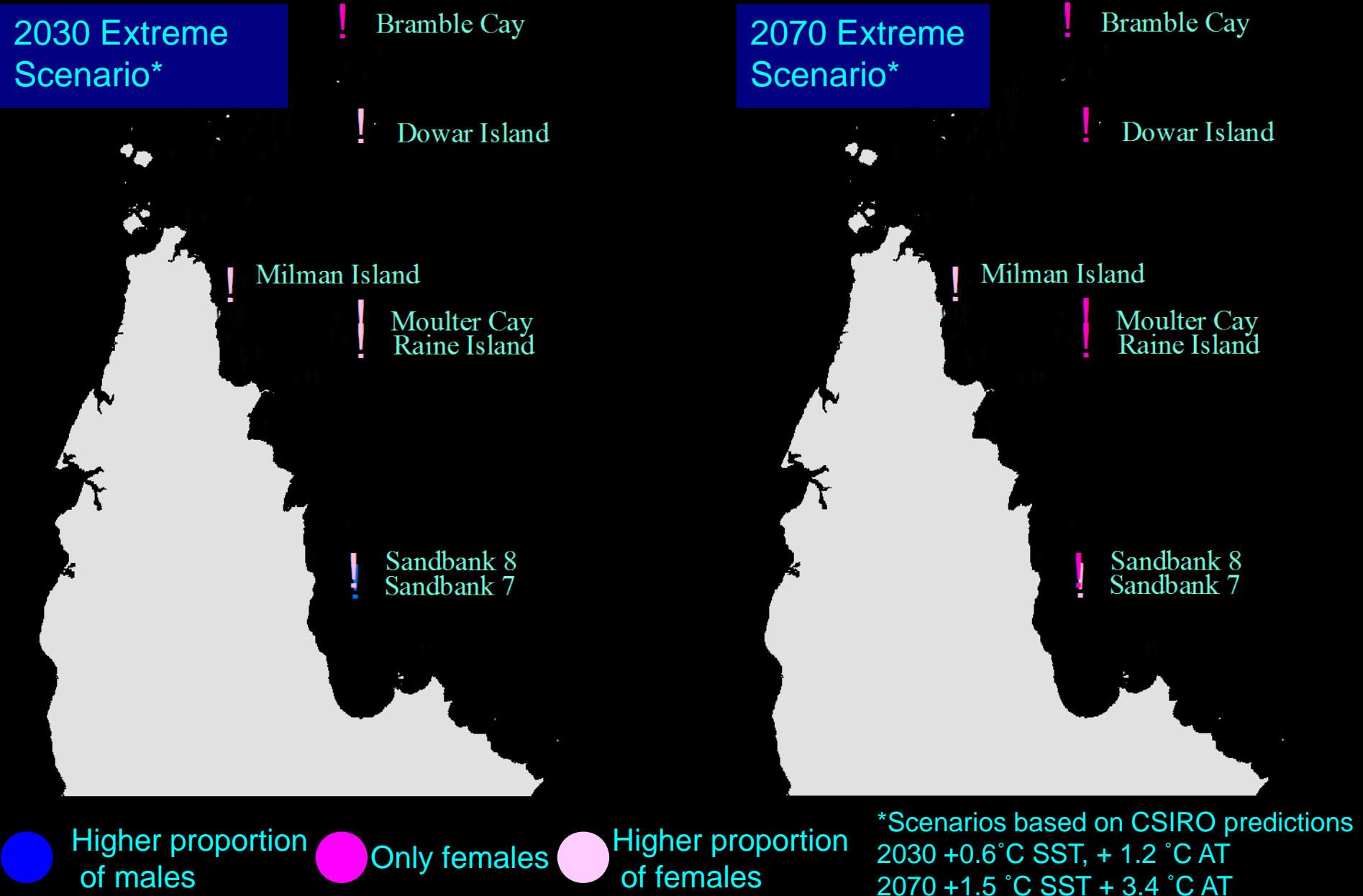
- Temperature plays a role on embryo development, hatching success and hatchling sex ratio
- Successful egg incubation (24- 33°C)
- Pivotal temperature (~29°C), 50:50 sex ratio is produced
- Warmer temperature produce more females and cooler temperatures produce more males



Sea turtles and temperature



Sea turtles and increases in temperature

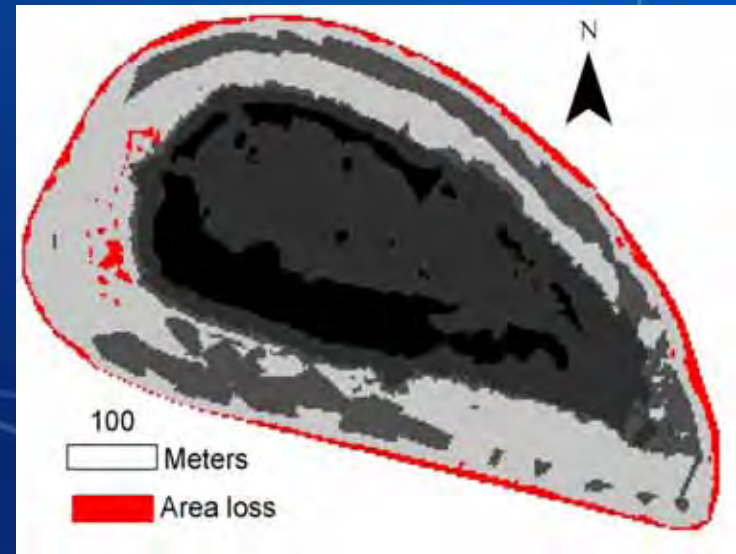




Sea turtles and sea level rise

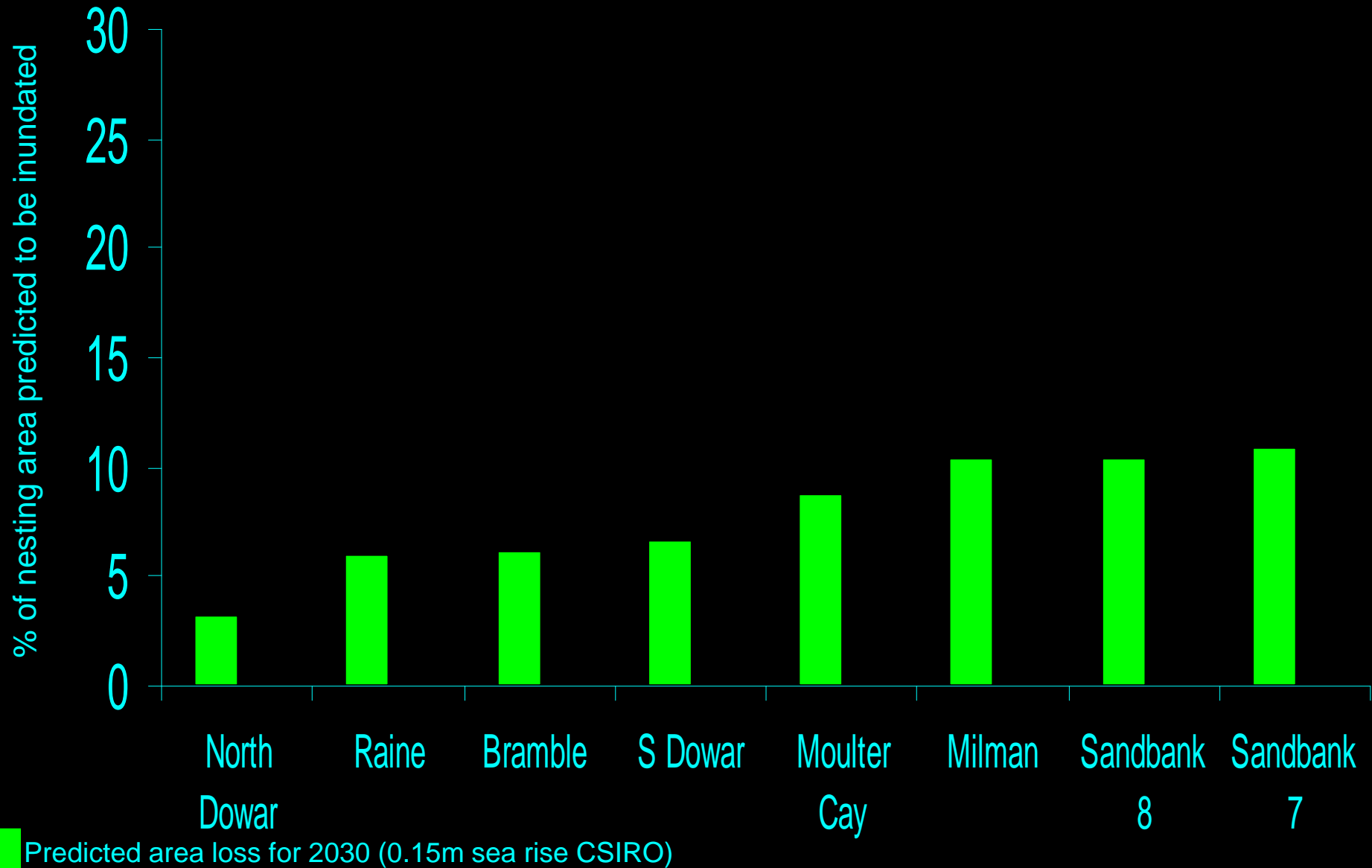
- Inundation and flooding of beaches
- Shoreline erosion
- Rise of water table

Amplification of density dependent issues, reduction of optimal nesting sites, increase egg mortality



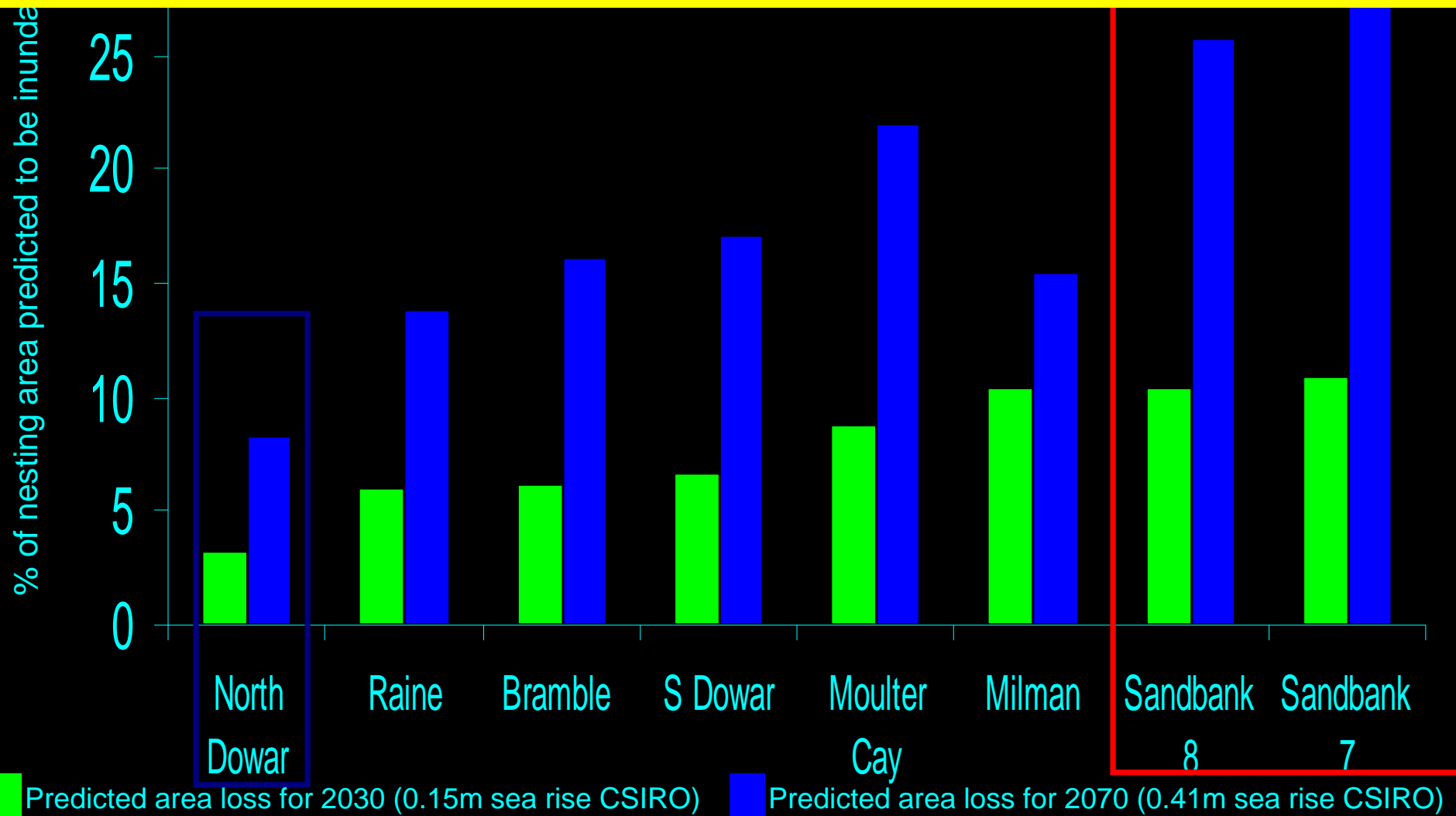
Predicted area loss for 2070 (0.41m sea rise CSIRO)

Sea turtles and sea level rise



Sea turtles and sea level rise

Results indicate that up to 34% of available nesting area across all rookeries studied may be inundated as a result of SLR





Sea turtles and cyclones

Impacts from cyclones include:

- Alteration of nesting habitat (beach erosion)
- Mortality of eggs (inundation and exposure of nests)

As climate change progresses:

- Intensification of cyclones (more intense cyclones).
Lower hatching success, nest flooding is higher
- Uncertainties on whether there will be geographic shift in cyclone patterns and/or changes in cyclone numbers .





Sea turtles and cyclones



Applied the latest climate models used by CSIRO (9 models) to study region

Model
Mk3.0_A2_M20th
ECHAM5
GFDL 2.0
GFDL 2.1
MIROC 3.2 - medres
Mk3.5 - A2 - B35
UK HADCM3
GFDL 2.1
MIROC 3.2 - medres

Great variation in predictions among various climate models.

All the models predict a reduction in number of cyclones

nGBR green turtle population will experience little impact from cyclonic activity in the future.



Which threat to manage?



Vs



Vs



OVERALL
Vulnerability of each
nesting ground

=

Vulnerability to
**increased
temperature**

*0.55

+

Vulnerability to
**cyclonic
activity**

*0.27

+

Vulnerability
to **sea level
rise**

*0.18

Feminization of turtle
population /reduction of
hatching success.

Density dependent issues,
reduction of nesting sites,
Increase egg mortality.

Reduction in
hatching success,
destruction of
nesting habitat,
stranding.

0.55

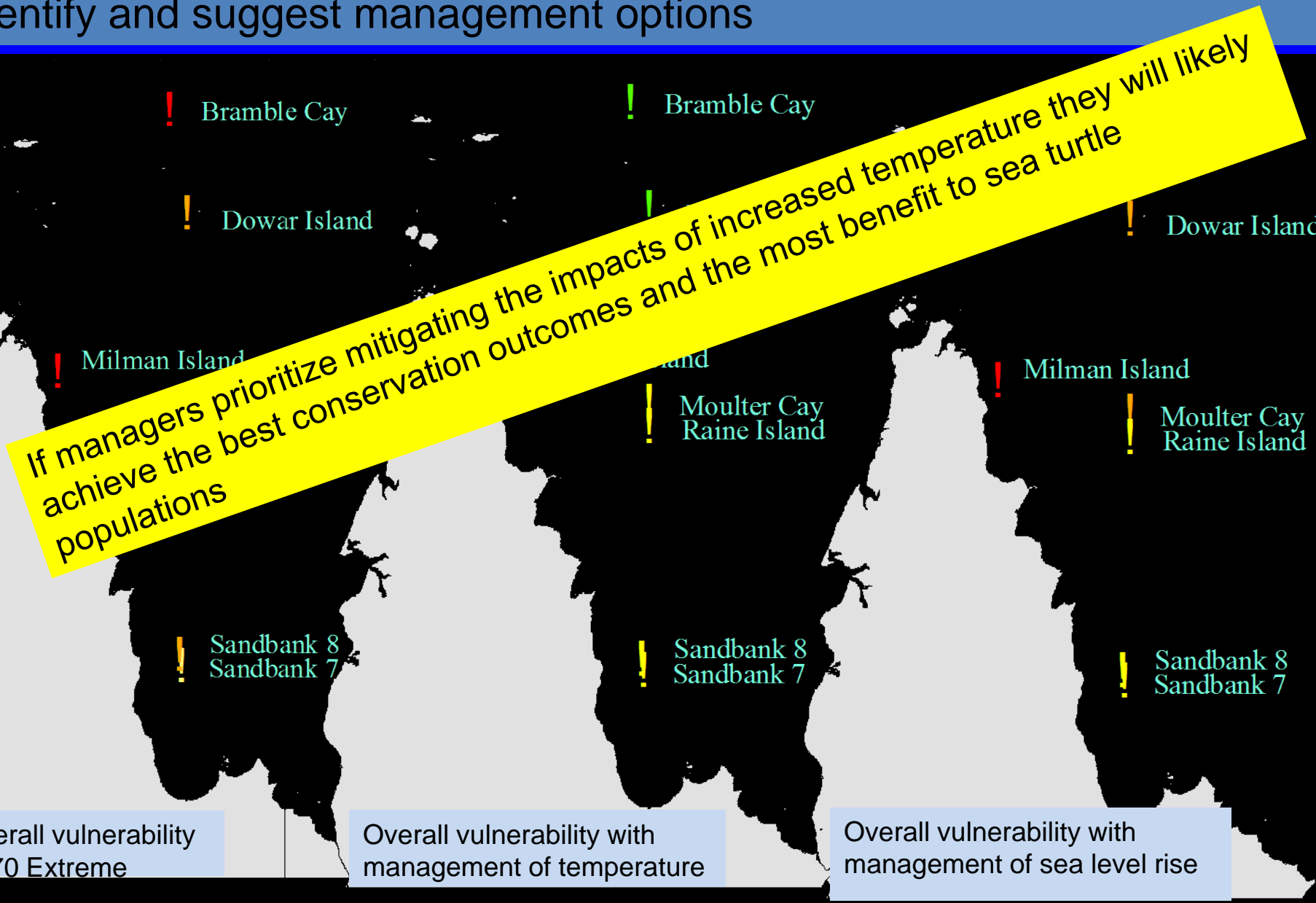
Vs

0.27

Vs

0.18

Identify and suggest management options



Low Intermediate High Extreme

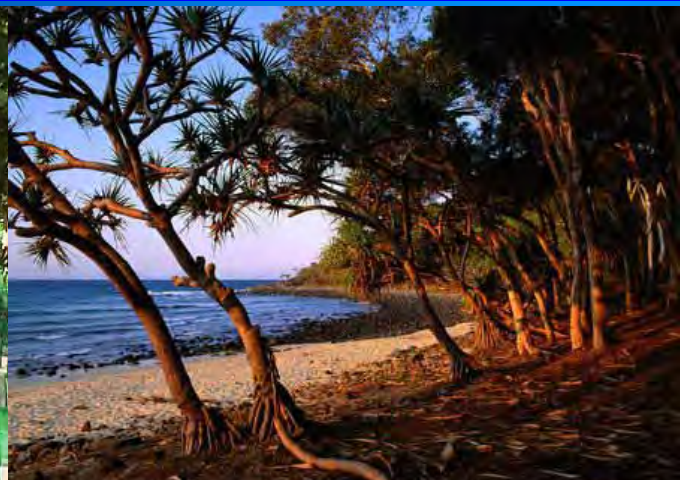
Identify and suggest adaptation strategies



Shading of incubating nests



Relocation of clutches into Naturally cooler zones.



Tree planting, re-vegetation programs.



Sand nourishment.



Artificially incubate eggs



Artificial beach, sand coloring

Identify and suggest adaptation strategies

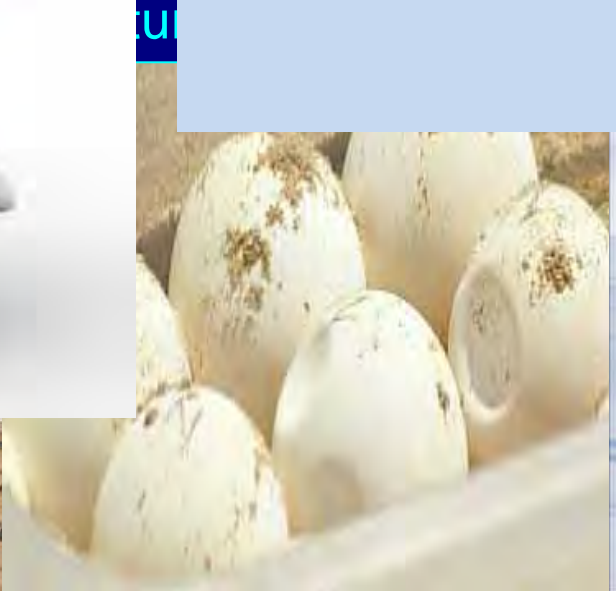


Uncertainty about the feasibility, effectiveness, risks and benefits of most of the active management measures. Need for:

- risk-based studies to investigate which management measures are feasible and cost-effective

Sha

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Sand nourishment.

Artificially incubate eggs

Artificial beach, sand coloring



Management action

Systematic decision-theory framework

Feasibility

Management efficiency =

Costs

BENEFIT
e.g. population growth *

PROBABILITY
OF SUCCESS *

WEIGHTING

Opportunities

Costs

Constraints

Help Save Our Turtles!



Reduce harvest

Say "NO" to Turtle Eggs

Reduce pollution



Protect key habitat



Legislation



Environmental education

Need to increase sea turtles resilience to enhance their adaptive capacity to climate change!