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Coral Reef Studies

Vulnerability of sea turtles to climate change

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Sea turtles in Australia

Green turtle

There are seven species of sea turtle in the world

Six of them occur (nest and feed) in Australia

Flatback turtle
(endemic to Australia)

Ecological role
(maintain healthy seagrass bed, balance food webs)

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

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Depleted populations

Traditional hunting

Boat strike

Illegal trade

- 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

Predation by introduced species

Pollution/ bycatch

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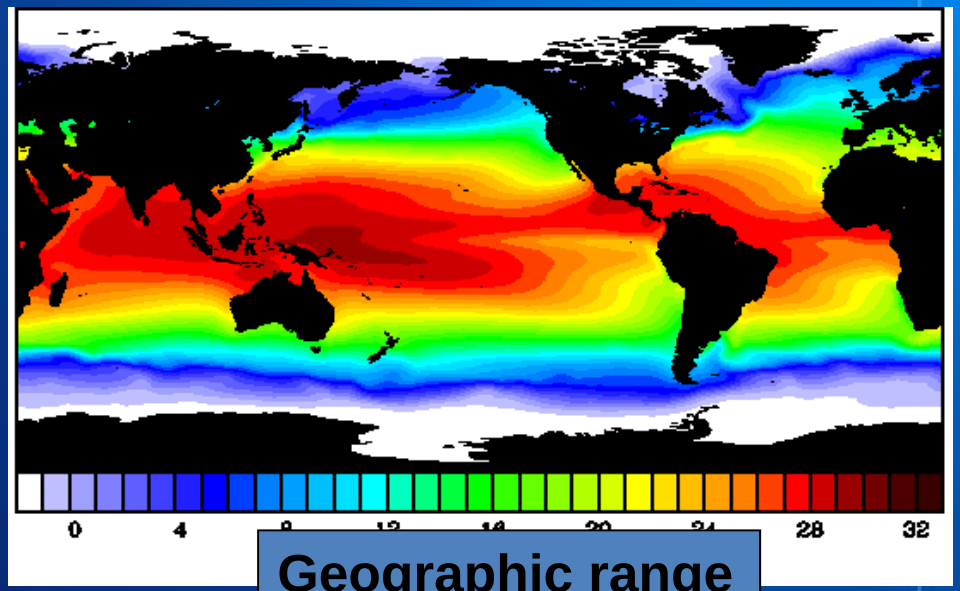
Sea turtles and climate change

Reproductive output (nesting grounds)



Geographic range

Foraging ecology

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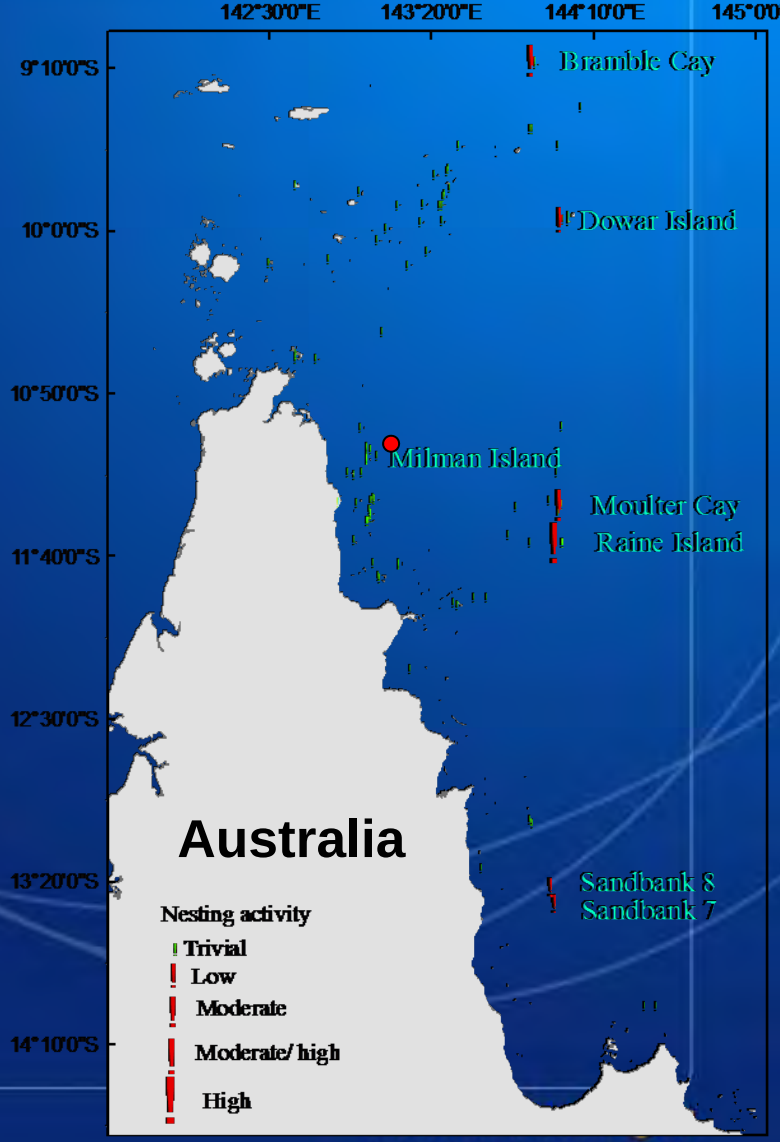
Sea turtles and climate change

Reproductive output (nesting grounds)



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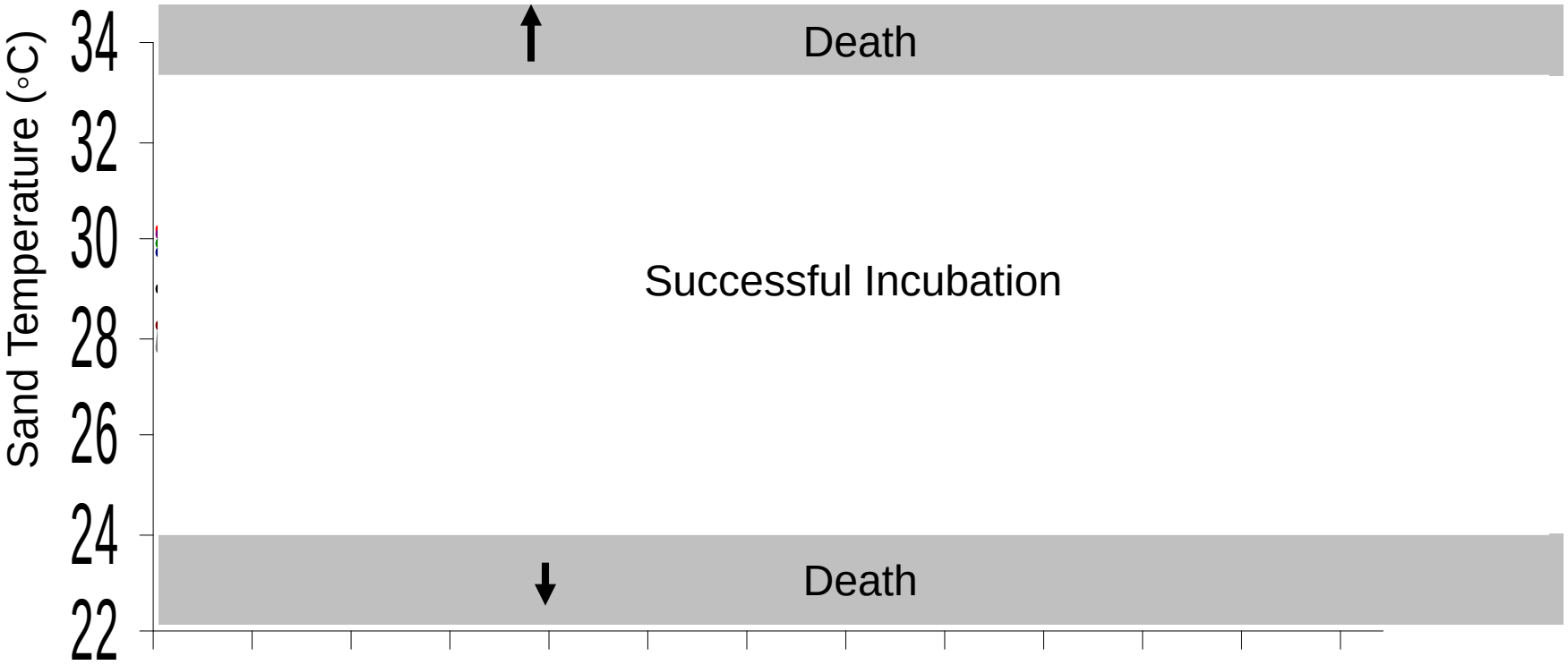
Sea turtles and temperature



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

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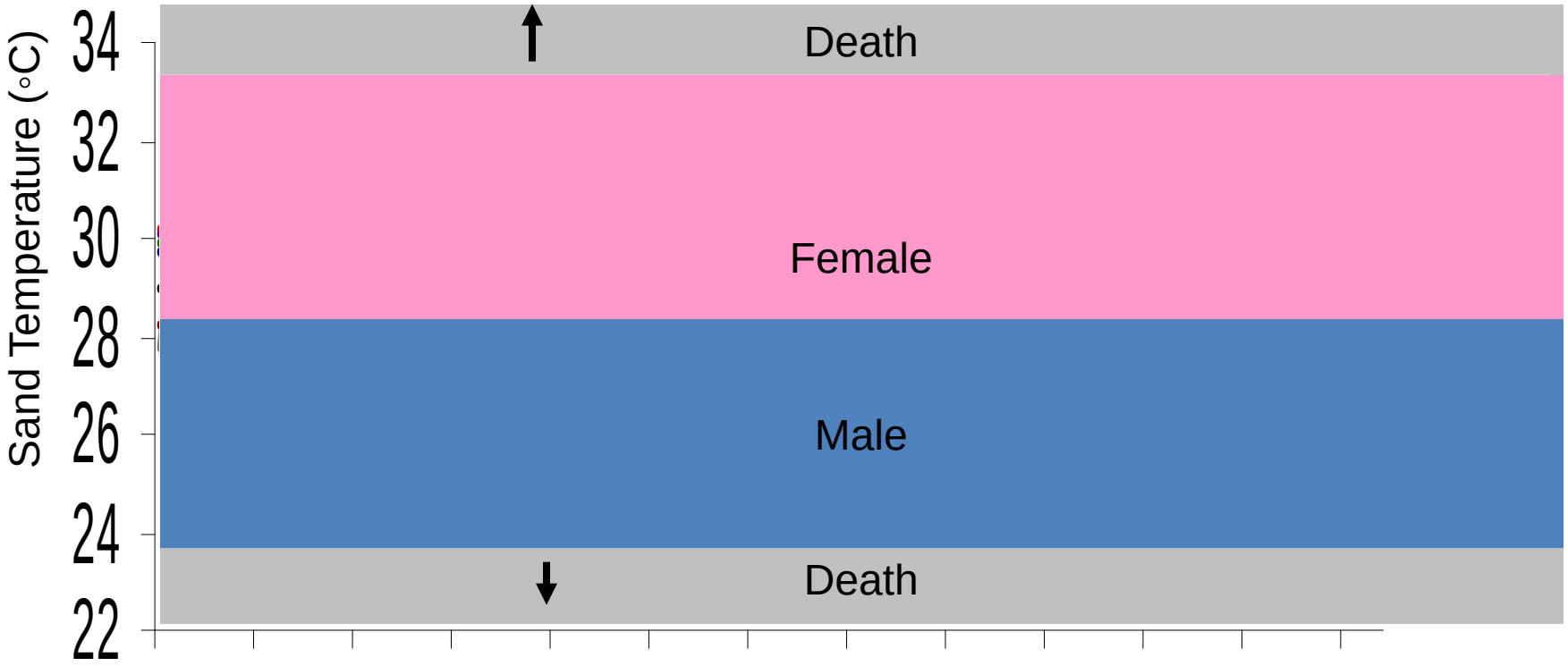
Sea turtles and temperature



- 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

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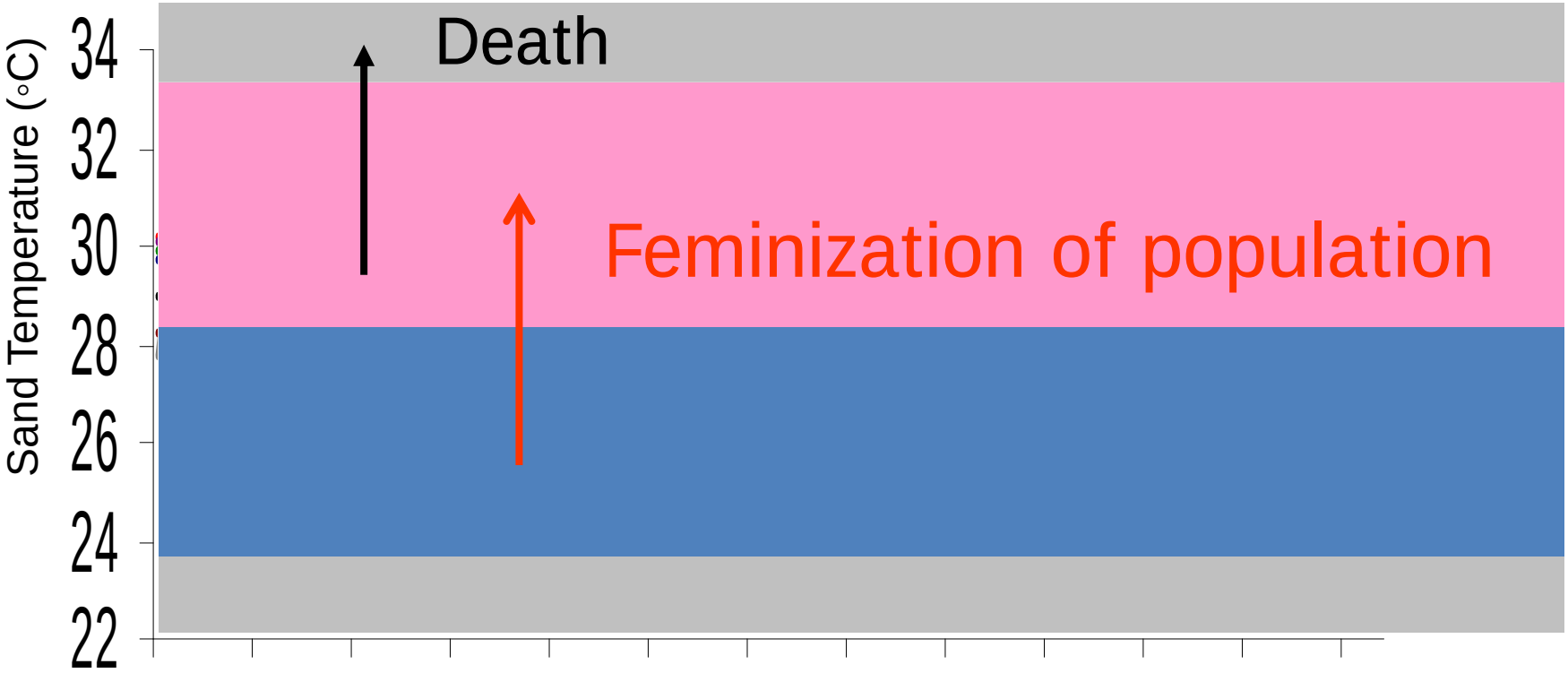
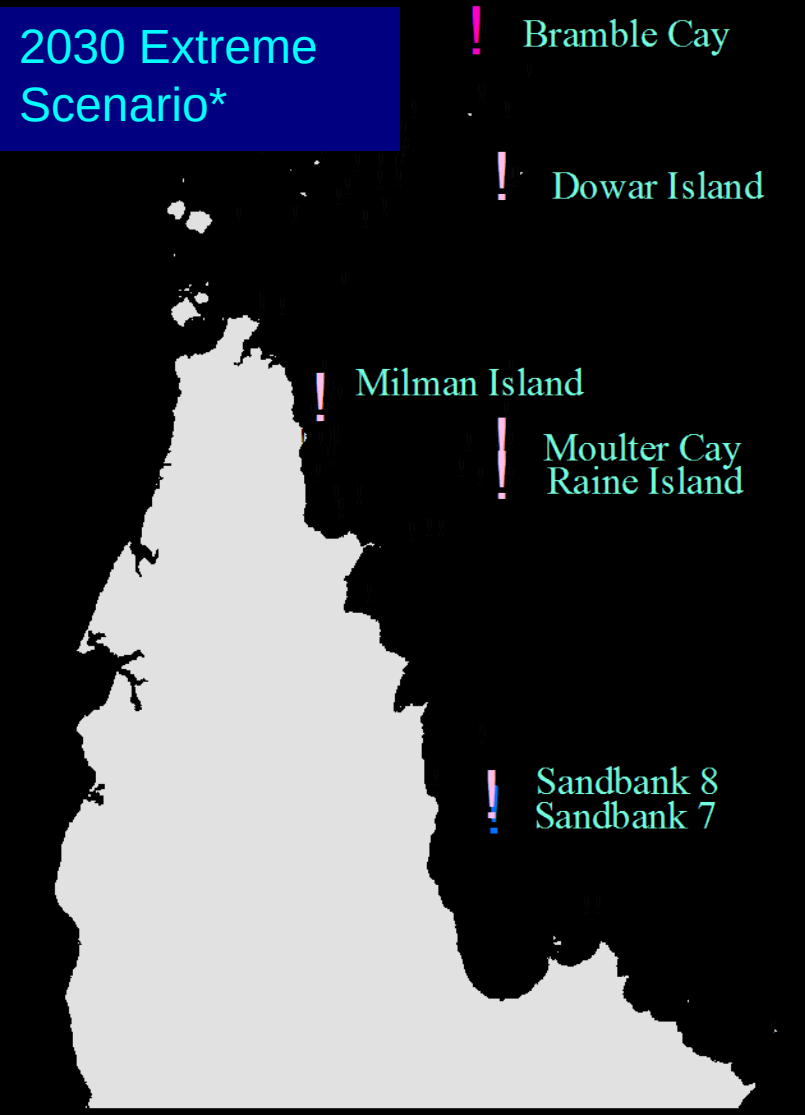
Sea turtles and temperature



Sea turtles and increases in temperature



Higher proportion of males

Only females

Higher proportion of females

*Scenarios based on CSIRO predictions
2030 +0.6˚C SST, + 1.2 ˚C AT
2070 +1.5 ˚C SST + 3.4 ˚C AT

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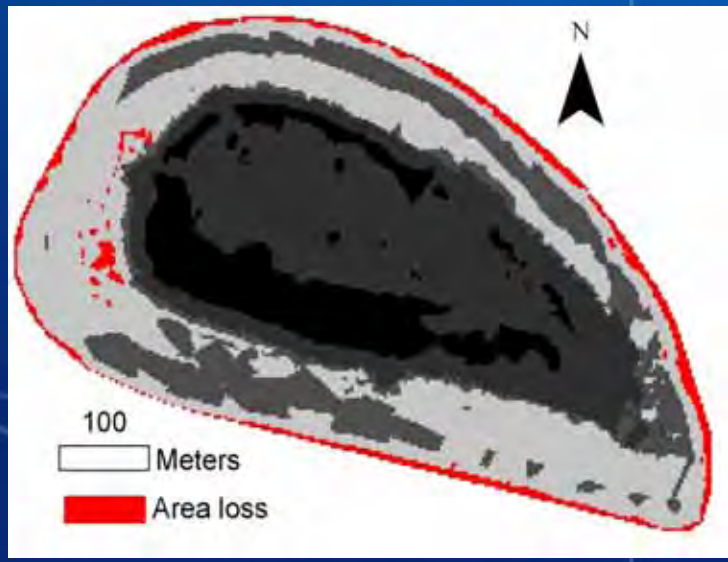
Sea turtles and sea level rise

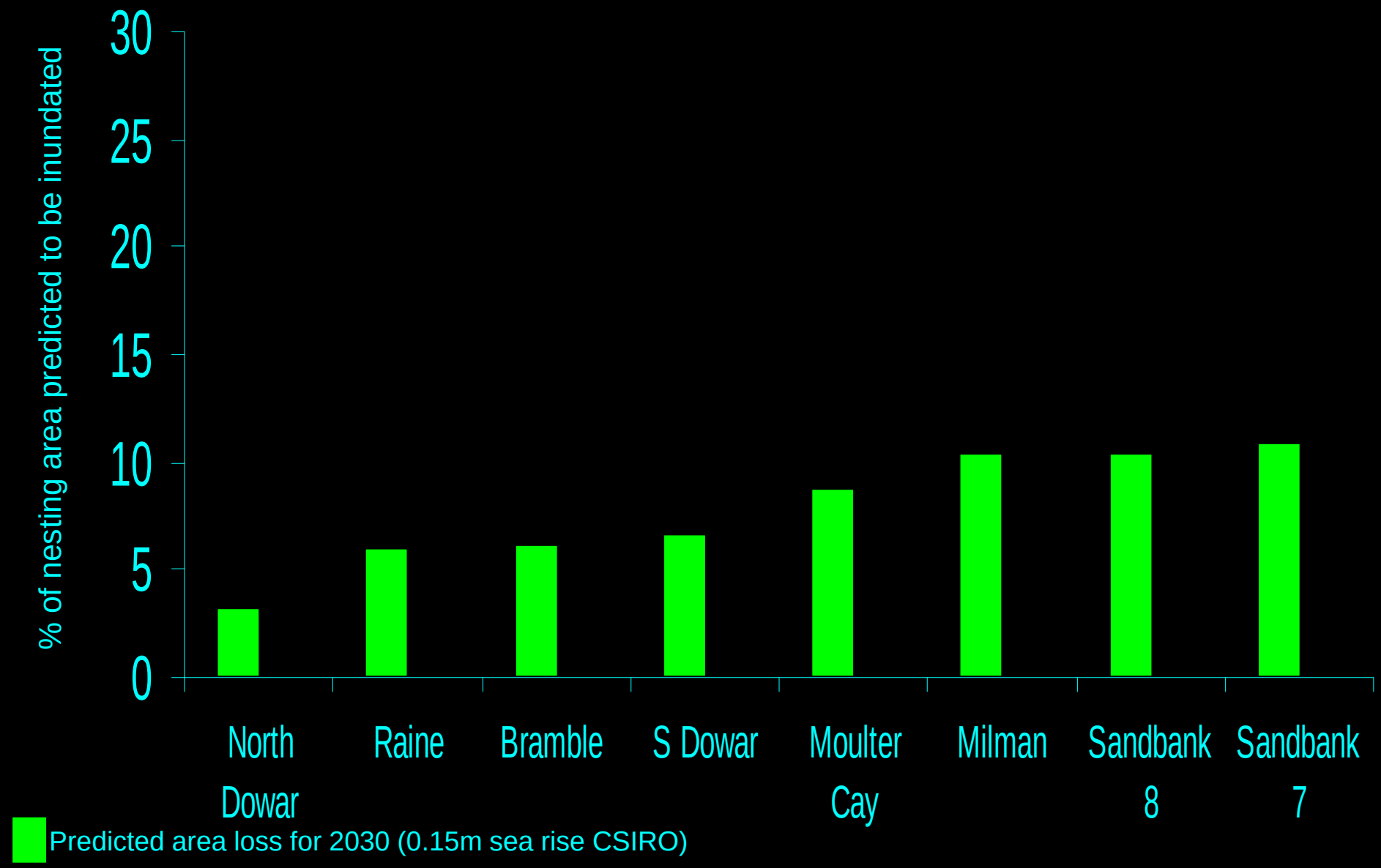
- Inundation and flooding of beaches
-Shoreline erosion
-Rise of water table

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



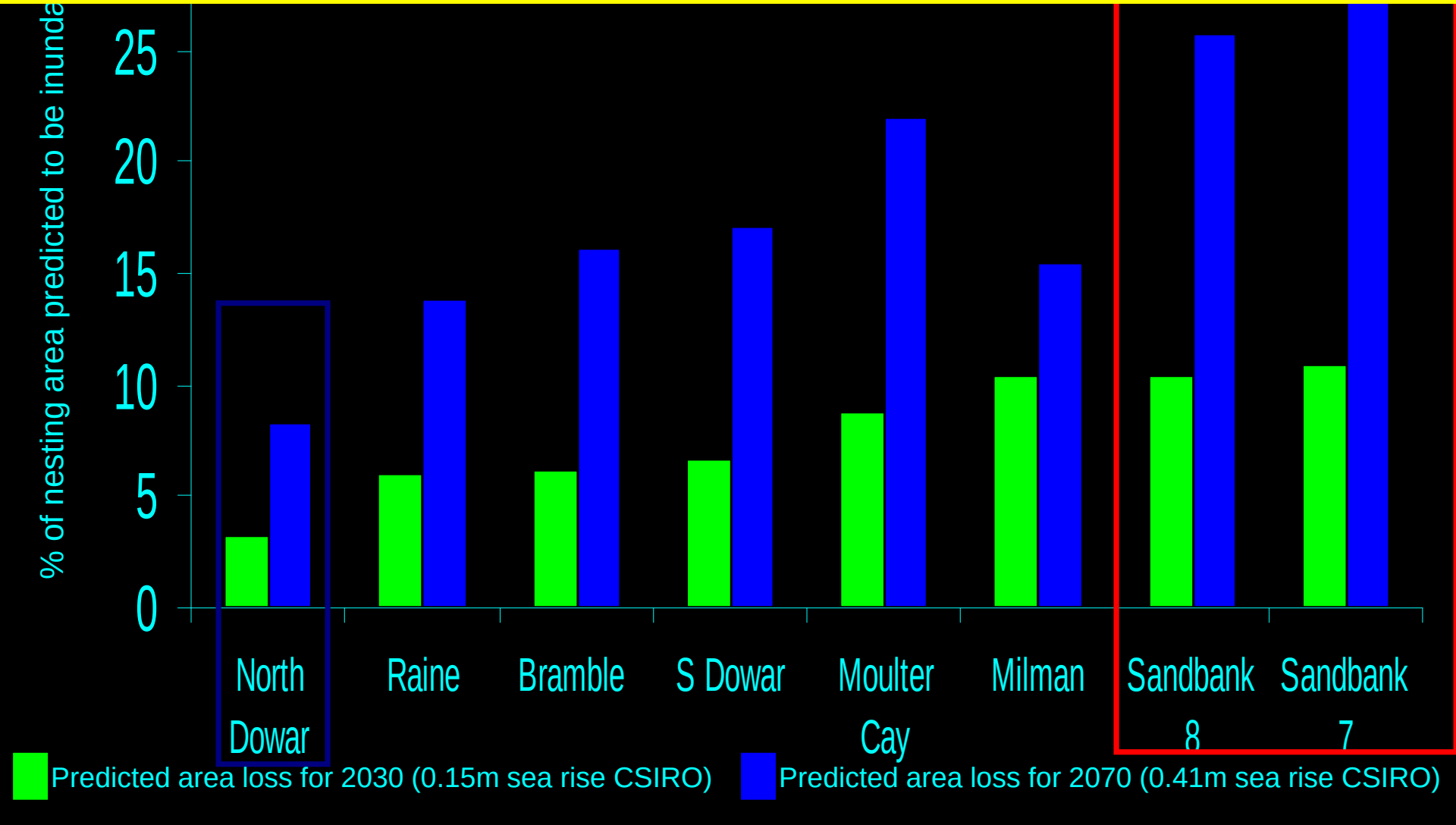
Predicted area loss for 2070 (0.41m sea rise CSIRO)

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



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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 .

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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.

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Which threat to manage?

Vs

Vs

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**

?

OVERALL Vulnerability of each nesting ground

=

Vulnerability to **increased temperature** ***0.55**

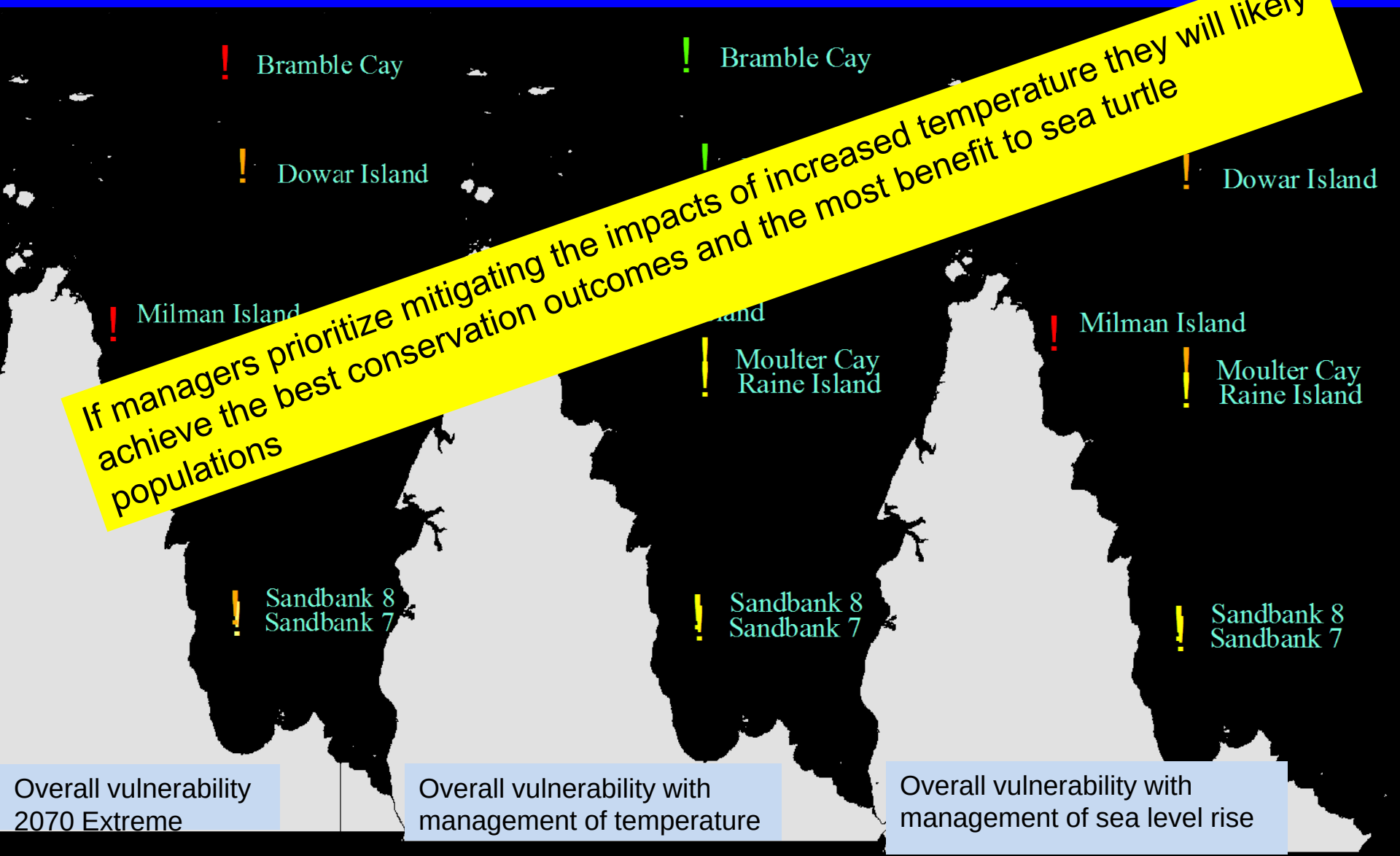
+

Vulnerability to **cyclonic activity** ***0.27**

+

Vulnerability to **sea level rise** ***0.18**

Identify and suggest management options



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

Sand nourishment.

Artificially incubate eggs

Artificial beach, sand coloring

Future work: Regional scale

Management action

Systematic decision-theory framework

Feasibility

Costs

Opportunities

Constraints

Management efficiency =

BENEFIT
e.g. population growth

*

PROBABILITY
OF SUCCESS

*

WEIGHTHING

Costs

Reduce harvest

Reduce pollution

Environmental education

Protect key habitat

Legislation

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