Appendix G

Country Paper: Singapore

Dr. Chou Loke Ming
Professor, Department of Biological Sciences
National University of Singapore
Science Drive, Singapore

Dr. Loke Ming is currently Professor in the Department of Biological Sciences, National University of Singapore. He is a coral reef biologist and has, in recent years, focused more on coastal management and reef restoration.

He has also been involved with many regional initiatives dealing with the marine environment and has provided consultancy services to international and regional agencies such as UNEP-COBSEA (Coordinating Body on the Seas of East Asia).

Dr. Loke Ming is a member of the Scientific Advisory Committee of the Global Coral Reef Monitoring Network of the International Coral Reef Initiative.

ANTICIPATED IMPACTS OF CLIMATE CHANGE ON MARINE BIODIVERSITY BASED ON FIELD SITUATIONS THAT SIMULATE CLIMATE CHANGE SCENARIOS IN SINGAPORE

L.M. Chou
Department of Biological Sciences
National University of Singapore

International Conference-Workshop "Biodiversity and Climate Change in Southeast Asia: Adaptation and Mitigation"
Manila, Philippines, 19-20 February 2008.

Climate change will affect natural systems and cause significant impacts on biodiversity (IPCC, 2007).

Elevated sea temperature.
Ocean acidification.

Changes in salinity, dissolved oxygen, circulation patterns from extreme weather.

Natural systems constantly adapting to changes/impacts.

Ecosystem response can be examined from existing field conditions that simulate climate change impacts.

1. Natural colonisation of newly-formed habitats.

2. Heavy sedimentation.

3. Salinity depression.

4. Elevated sea temperature.

NATURAL COLONISATION OF NEWLY-CREATED HABITATS

Sea-level rise will result in inundation of low beaches.



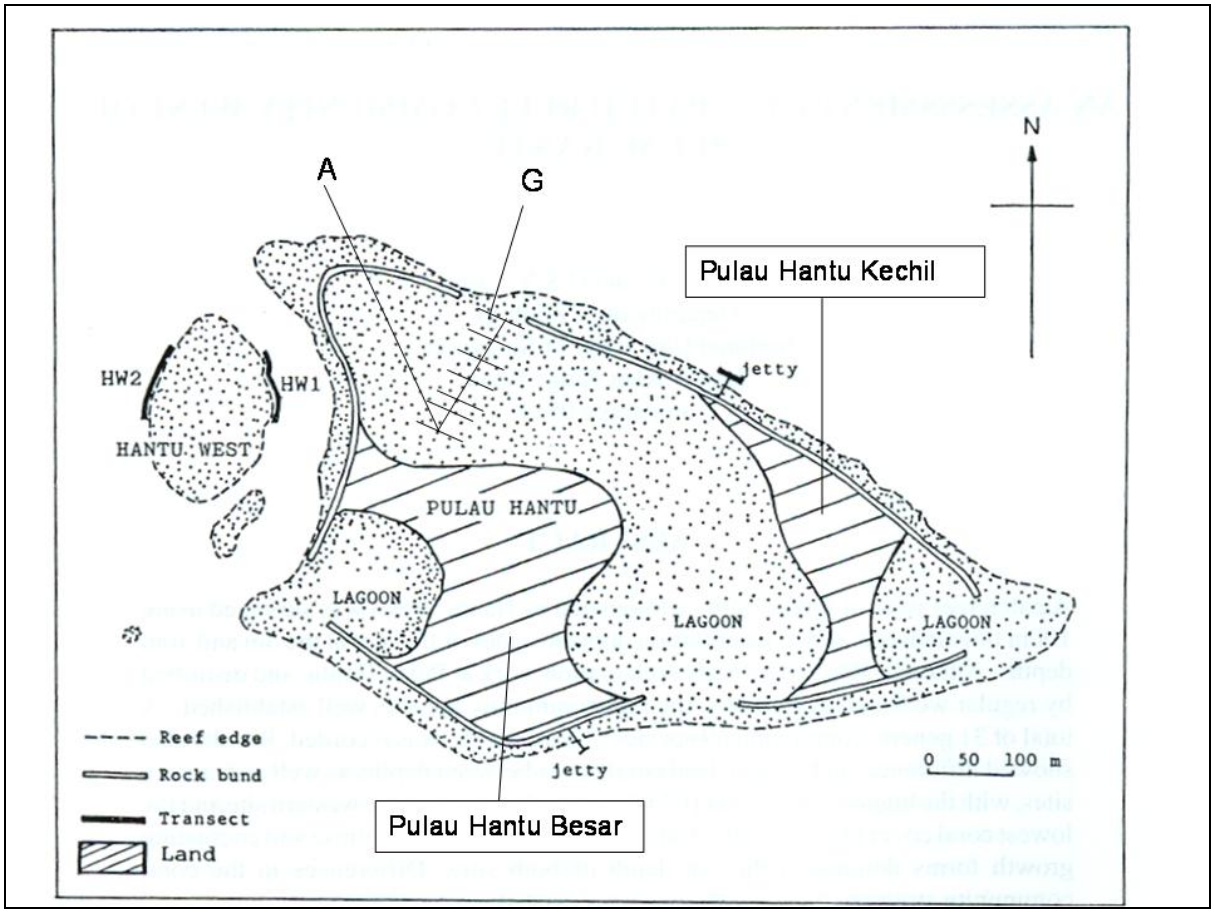

PULAU HANTU

Originally two small islands:
Pulau Hantu Besar – 2 ha
Pulau Hantu Kechil – 0.4ha

Reclamation between March 1974 and April 1975.

Combined land area increased to 12.2ha.
Common reef flat in between islands converted to sandy lagoon.

Natural colonisation of lagoon assessed in 1992.


N
A
G
Pulau Hantu Kechil
jetty
HW2
HW1
HANTU WEST
PULAU HANTU
LAGOON
LAGOON
LAGOON
jetty
0 50 100 m
Reef edge
Rock bund
Transect
Land
Pulau Hantu Besar

Percent live cover of benthic organisms across transects at Pulau Hantu lagoon.

TRANSECT	A	B	C	D	E	F	G
Hard corals	0.02	0.15	0.34	0.1	1.1	0.7	0.3
Soft corals	0.02	-	0.02	-	-	0.3	-
Sponges	1.2	1.6	2.1	3.5	0.6	0.06	0.07
Seagrass	0.5	2.9	1.4	0.8	0.2	0.04	-
Macroalgae	3.4	5.7	5.2	5.7	18	16	2.1
Others	0.46	1.65	1.44	1.9	-	2.1	4.02
TOTAL	**5.6**	**12**	**10.5**	**12**	**19.9**	**19.2**	**6.49**

Percentage abundance and distribution of life forms across transects at Pulau Hantu lagoon.

TRANSECT	A	B	C	D	E	F	G
Hard corals	0.4	1.2	3.7	0.9	5.8	0.6	11.7
Soft corals	0.4	0.01	0.2	0.04	-	2.7	-
Sponges	21.4	12.9	22.5	32	2.8	5.1	2.5
Tunicates	7	2.2	1.6	6.5	1.4	-	-
Zoanthids	1	15	-	0.7	-	1.6	-
Anemones	-	-	-	-	-	0.4	3.9
Seagrass	8.9	22.8	14.9	6.7	0.8	-	-
Macroalgae	61	45.8	57.2	53.1	89.2	89.6	81.9

Natural colonisation after 17 years:

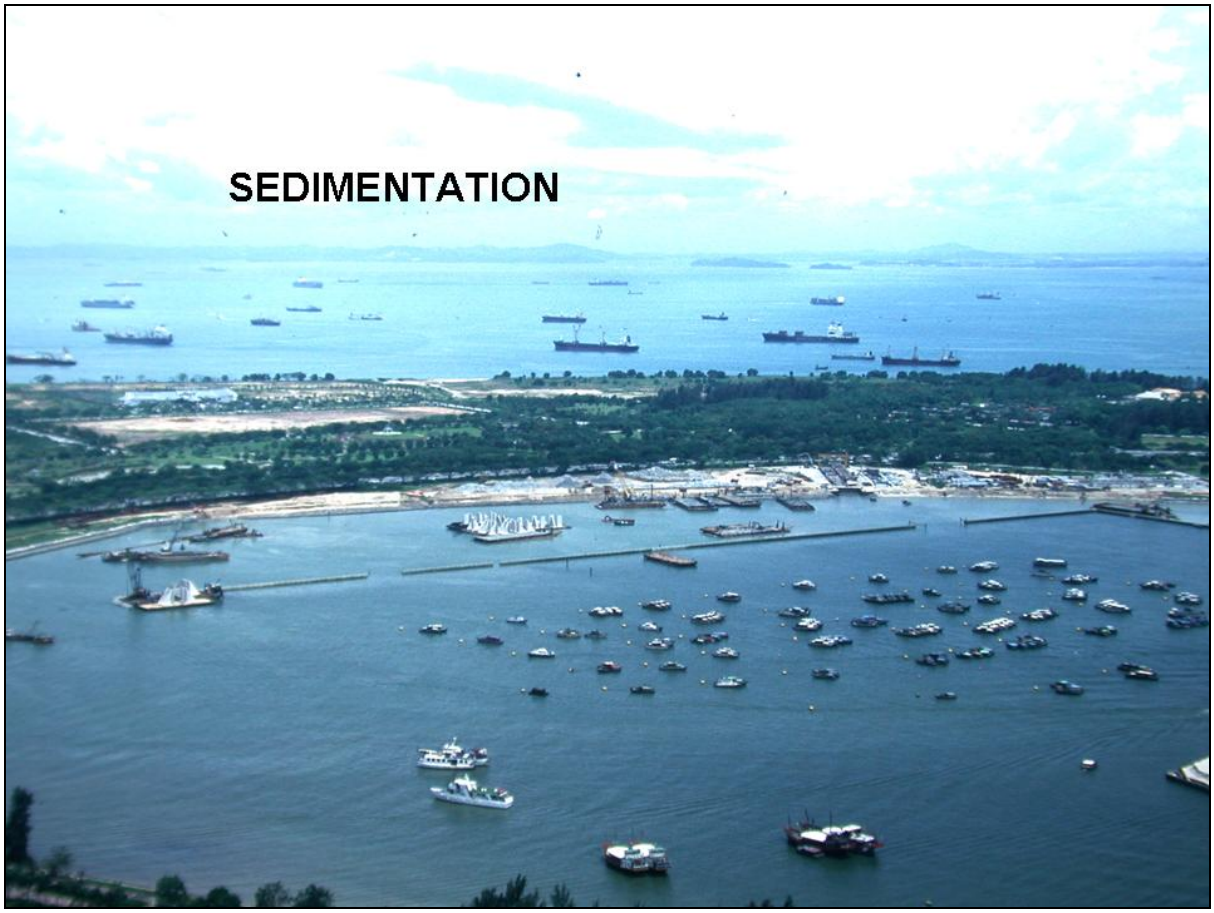
Percent cover of corals and reef-associated organisms ranged between 5.6 and 19.9%.

Main colonisers – macroalgae, seagrass, sponges.

Dominant macroalgae – *Sargassum*.
Seagrass – *Halophila*, *Enhalus*.

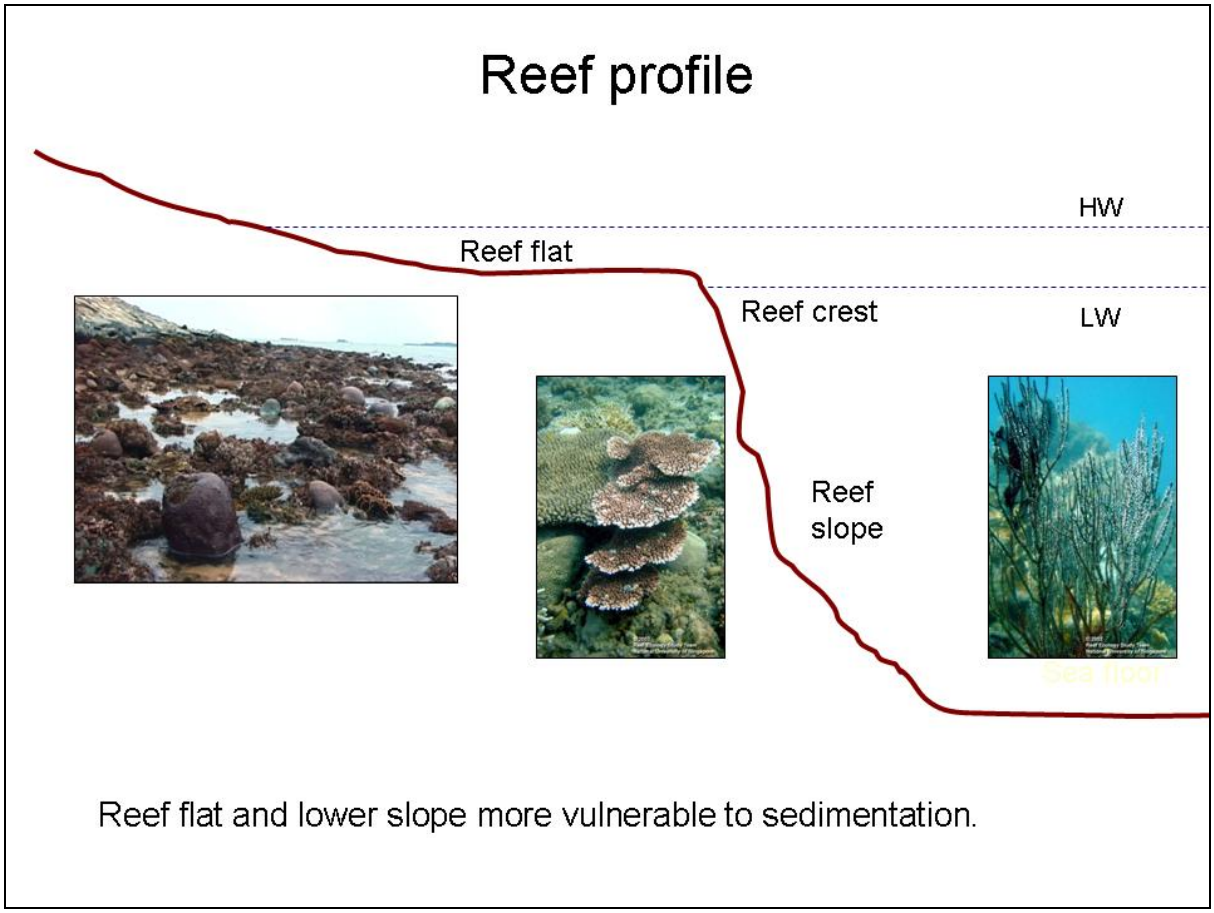
Hard corals – well-distributed, low in abundance, commonly associated with rocks.
Massives – *Goniopora, Porites, Favites, Favia, Goniastrea, Platygyra*.

Community structure similar to that of natural reef flats.


SEDIMENTATION

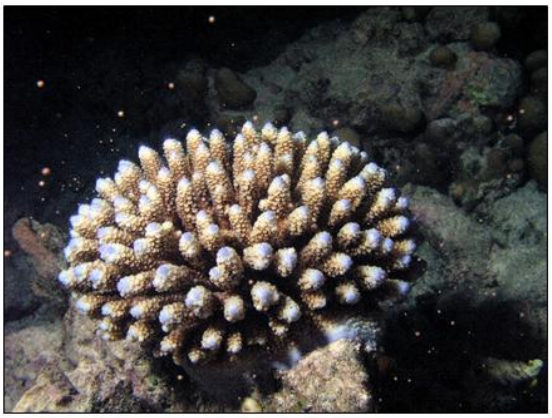

Before 1970s
© 2002
Reef Ecology Study Team
National University of Singapore


© 2002
Reef Ecology Study Team
National University of Singapor


Reef profile
HW
Reef flat
Reef crest
LW
Reef
slope
Reef flat and lower slope more vulnerable to sedimentation.

Mass spawning first reported in 2002.

Full moon Mar 2002
Apr 2003-2007



Reef flat and lower slope most affected.

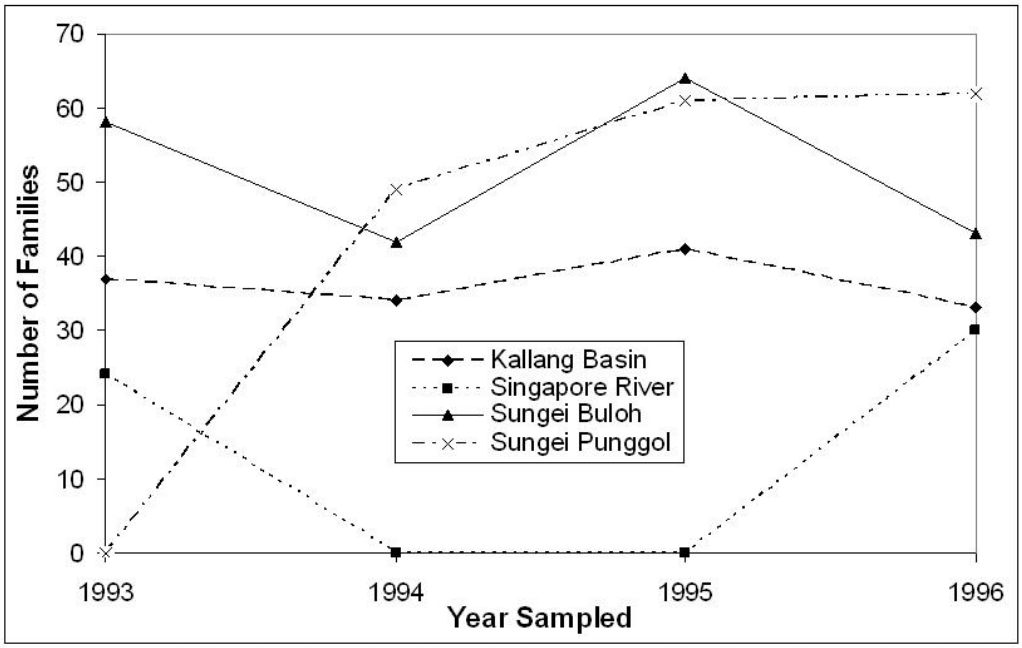
Reef crest and upper slope (to 6m depth) still supports vigorous growth.

Steady but gradual decline in live coral cover.

No significant loss of hard coral diversity (250 species with only 1 species, *Seriatopora pistillata,* locally extinct.)

Soft bottom benthic communities

Community structure change fairly responsive to environmental condition.



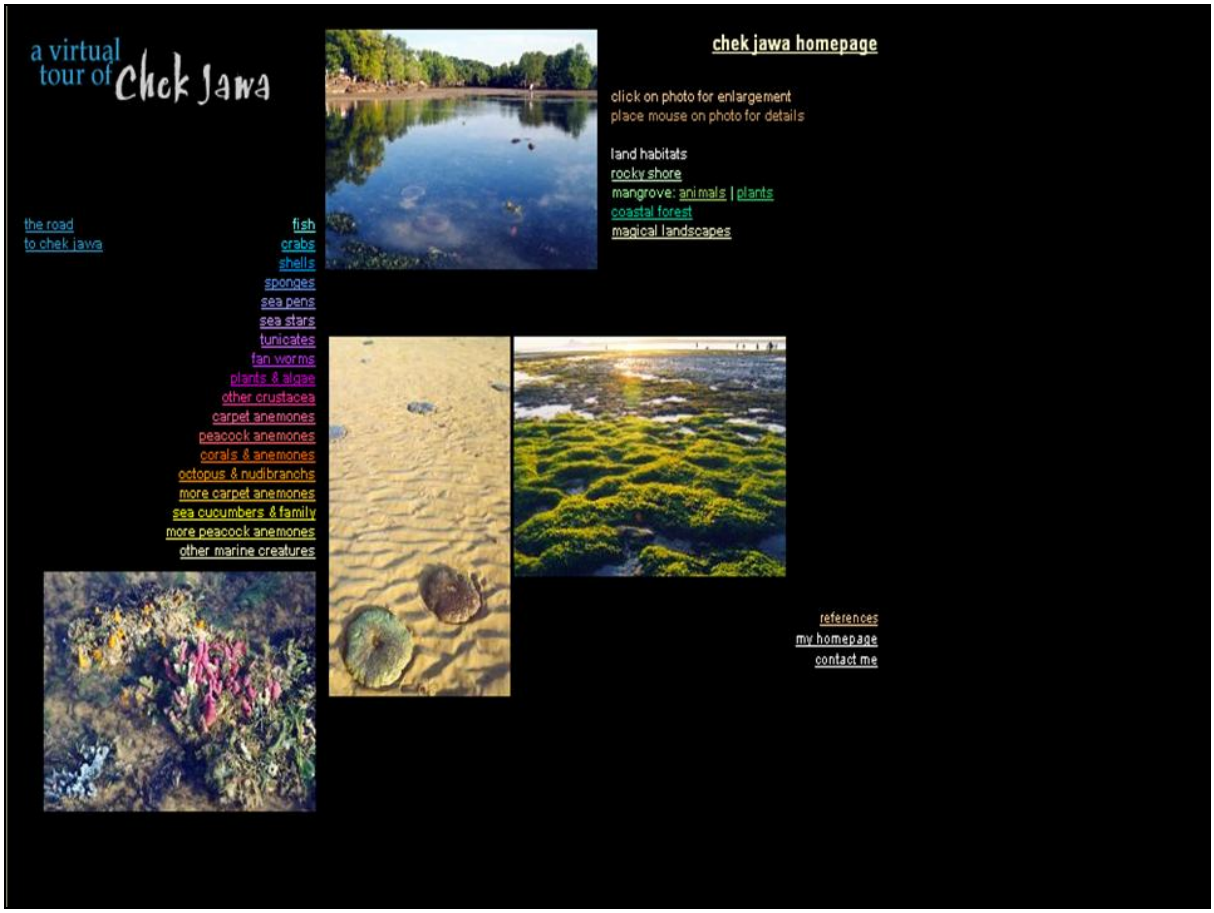
Temporal variation in diversity of benthic communities from four estuaries in relation to development activities. Improvement was evident at Sungei Punggol and Singapore River. Benthic communities can be used as indicators of environmental change.

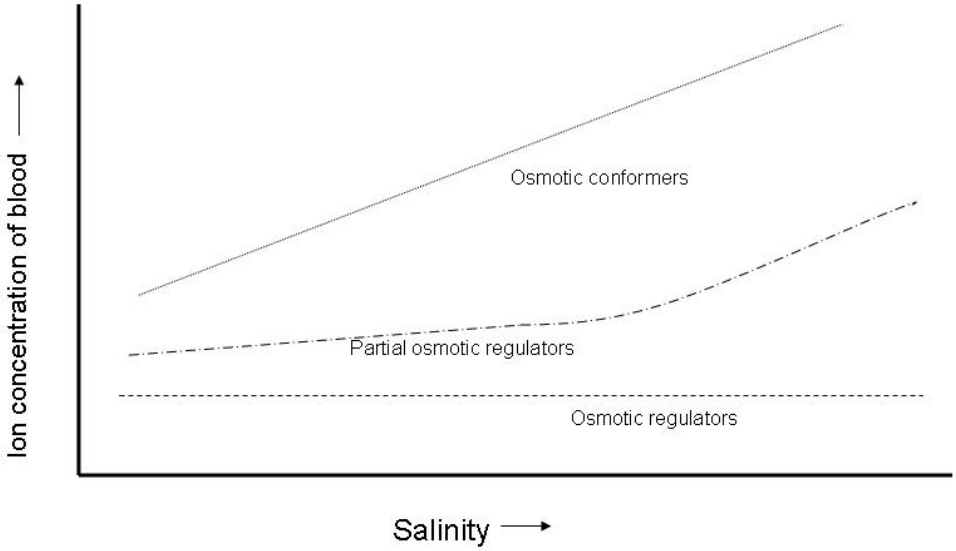
SALINITY DEPRESSION

Dec 2006/Jan 2007

Heavy rainfall over Southern Johor (heaviest in many decades).


Johor River
Chek Jawa
© CNES 2001


a virtual tour of Chek Jawa
chek jawa homepage
click on photo for enlargement
place mouse on photo for details
land habitats
rocky shore
mangrove: animals | plants
coastal forest
magical landscapes
the road to chek jawa
fish
crabs
shells
sponges
sea pens
sea stars
tunicates
fan worms
plants & algae
other crustacea
carpet anemones
peacock anemones
corals & anemones
octopus & nudibranchs
more carpet anemones
sea cucumbers & family
more peacock anemones
other marine creatures
references
my homepage
contact me



Some marine organisms can regulate the concentration of their body fluid so that they are not affected by change in salinity.
Some can partially regulate their body fluid concentration, while others cannot. These species have a difficulty if they cannot tolerate large changes in salinity.

ELEVATED SEA TEMPERATURE

1998 ENSO

June – SST 34.3^0 C (normally 29.5 – 31.5^0).

Widespread bleaching at unprecedented scale.

All hard coral species, some soft coral species and colonial sea anemones bleached.

Recovery occurred as SST returned to normal (20% mortality).

CONCLUSIONS

- Climate change impacts varied – direct and indirect.
- Biodiversity response – species, community, habitat.
- Enhance ecosystem resilience:
  - more effective management of natural habitats
  - innovative techniques and approaches
  - proactive rather than reactive.