CORAL MICRO-FRAGMENTATION: INNOVATIVE APPROACH TO CORAL RESTORATION FOR ENHANCING NATURE-POSITIVE TOURISM IN THAILAND

GSTC
Global Sustainable Tourism Council

GSTC Academic Symposium
5 August 2025, Fiji

Wichin Suebpala[1], Makamas Sutthacheep[1], Thamasak Yeemin[1], Sittiporn Pengsakun[1], Wanlaya Klinthong[1], Charernmee Chamchoy[1], Nipatpong Chuanchuen[2], Supawadee Photiyarach[3], Anaphat Nongkoo[4]

[1]Marine Biodiversity Research Group, Faculty of Science, Ramkhamhaeng University, Huamark, Bangkok, Thailand

[2]Asian Ecotourism Network, Bangkok, Thailand

[3]Thailand Science Research and Innovation, Samsen Nai, Phaya Thai, Bangkok, Thailand

[4]College of Innovation and Management, Suan Sunandha Rajabhat University, Dusit, Bangkok, Thailand

OUTLINE

- Ecosystem services of coral reefs
- Threats to coral reefs
- Coral reef restoration
- Bridging restoration activities to nature-positive tourism

Marine tourism and blue economy

Marine tourism activities

1. Snorkeling
2. SCUBA diving
3. Free Diving
4. Sea walking
5. Underwater scooter
6. Swimming
7. Kite surfing
8. Jet ski
9. Paraceling
10. Banana boat
11. Dolphin/whale boating
12. Long-tail boating
13. Sailing
14. Recreational fishing
15. Paddle board
16. Kayaking/canoeing
17. Surfboarding
18. Sunbathing

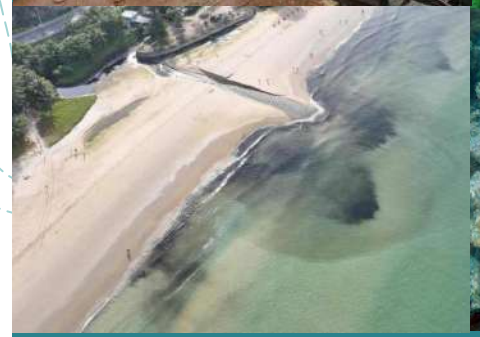
Use value

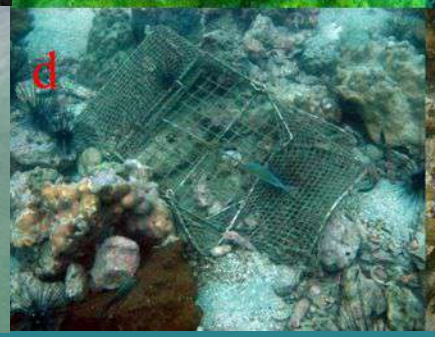
Tourism 12,515 million USD
Fisheries 4,381 million USD

It is estimated that the total economic value of mangroves, coral reefs and seagrass beds in Thailand in 2014 is 26,310 million USD

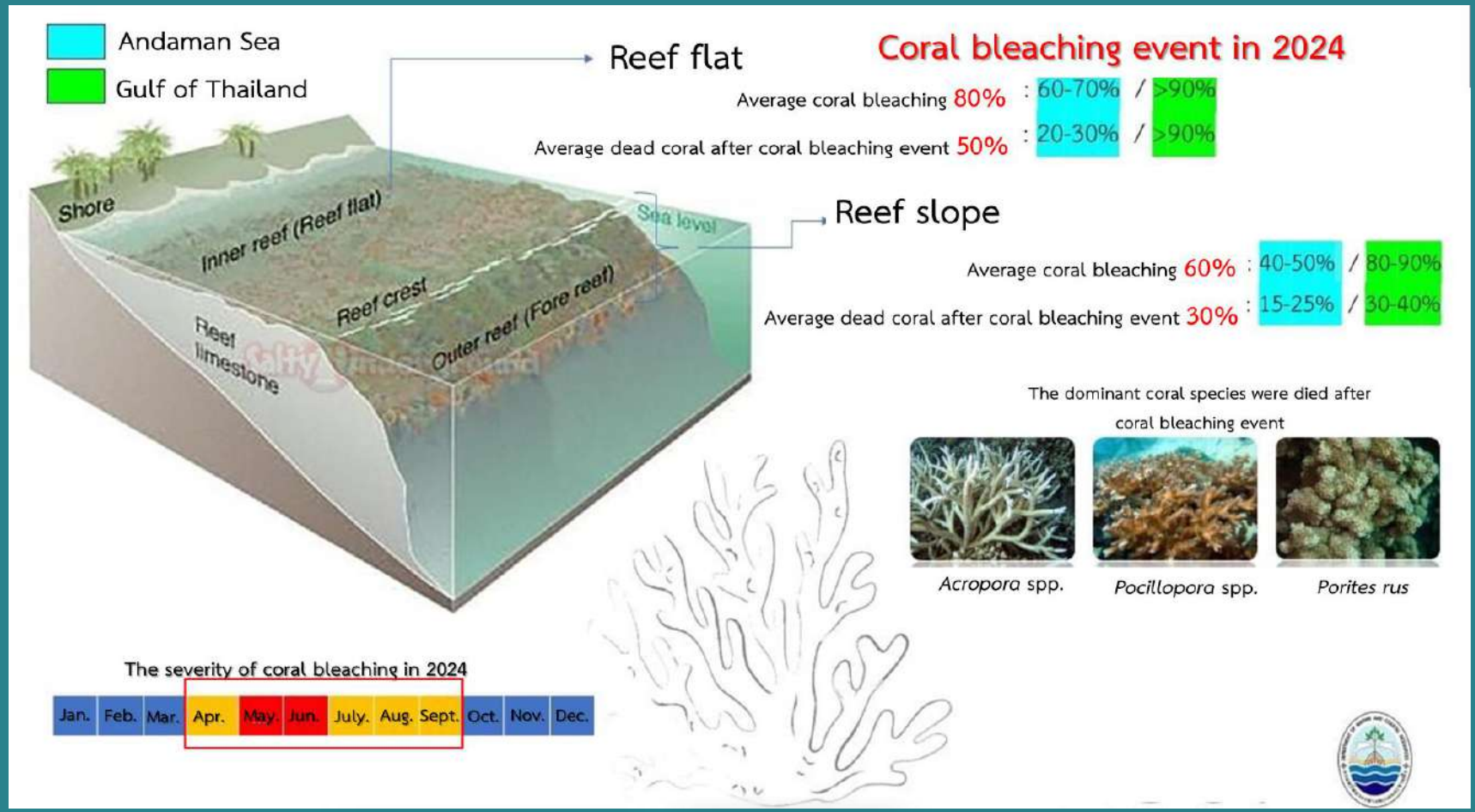
Source: Na Bang Chang (2015)

REEFS IN THE ANTHROPOCENE





REEFS IN CLIMATE CHANGE ERA

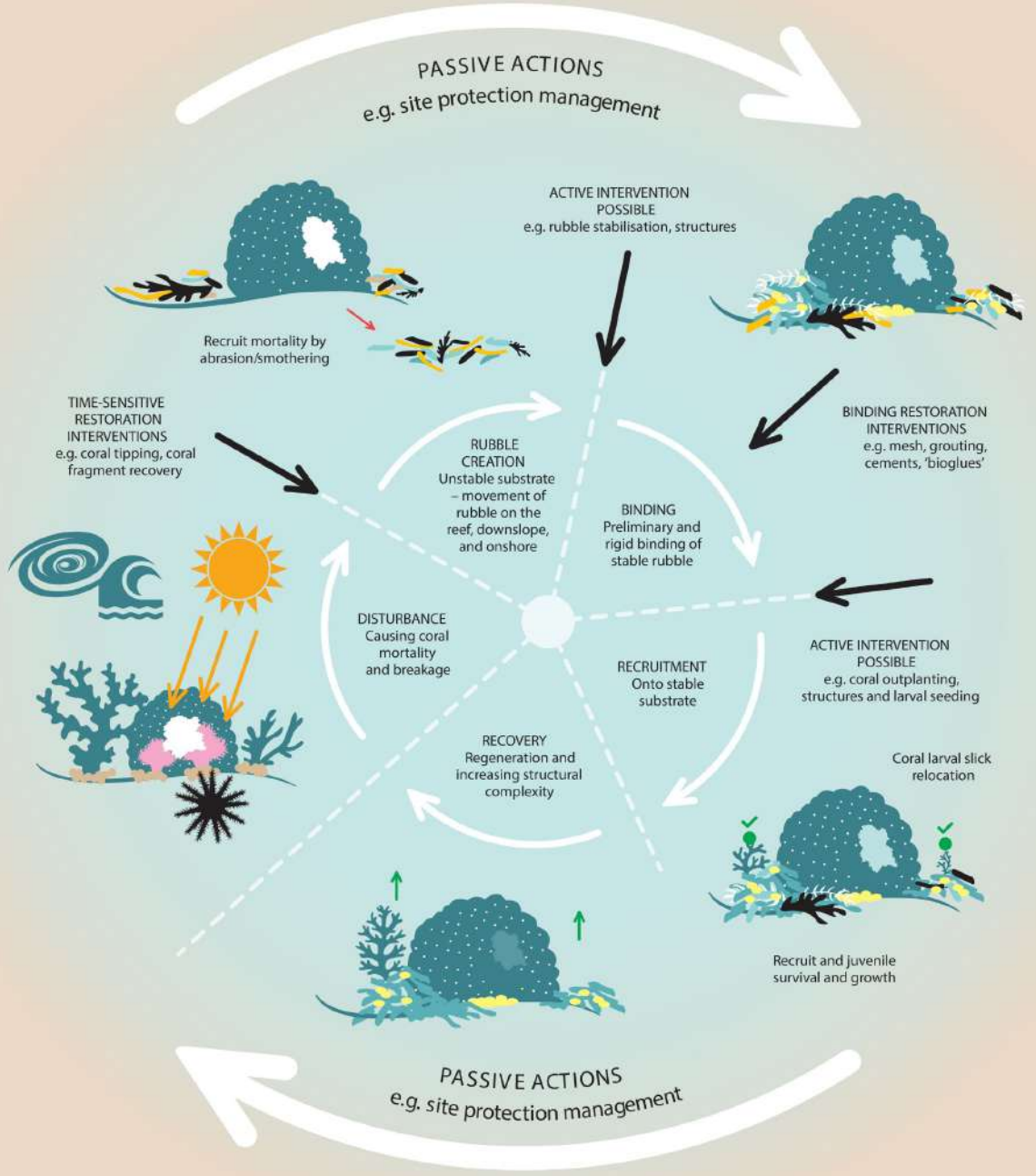


(DMCR, 2024; Filho, 2023; Suttacheep et al., 2013)

CORAL REEF RESTORATION

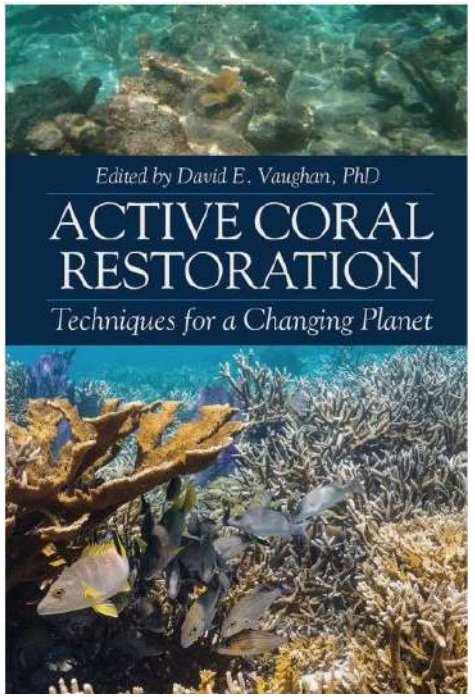
Hughes, et al. (2023) recommend combining two key concepts that can provide important insights into the dynamics and feasibility of restoration

- **Principles of ecological succession**
- **Responses and resilience of ecological systems to anthropogenic pressures.**



(Ceccarelli et al. 2020)

CORAL REEF RESTORATION IN THAILAND



(Yeemin et al. 2006; Manager Online, 2024)

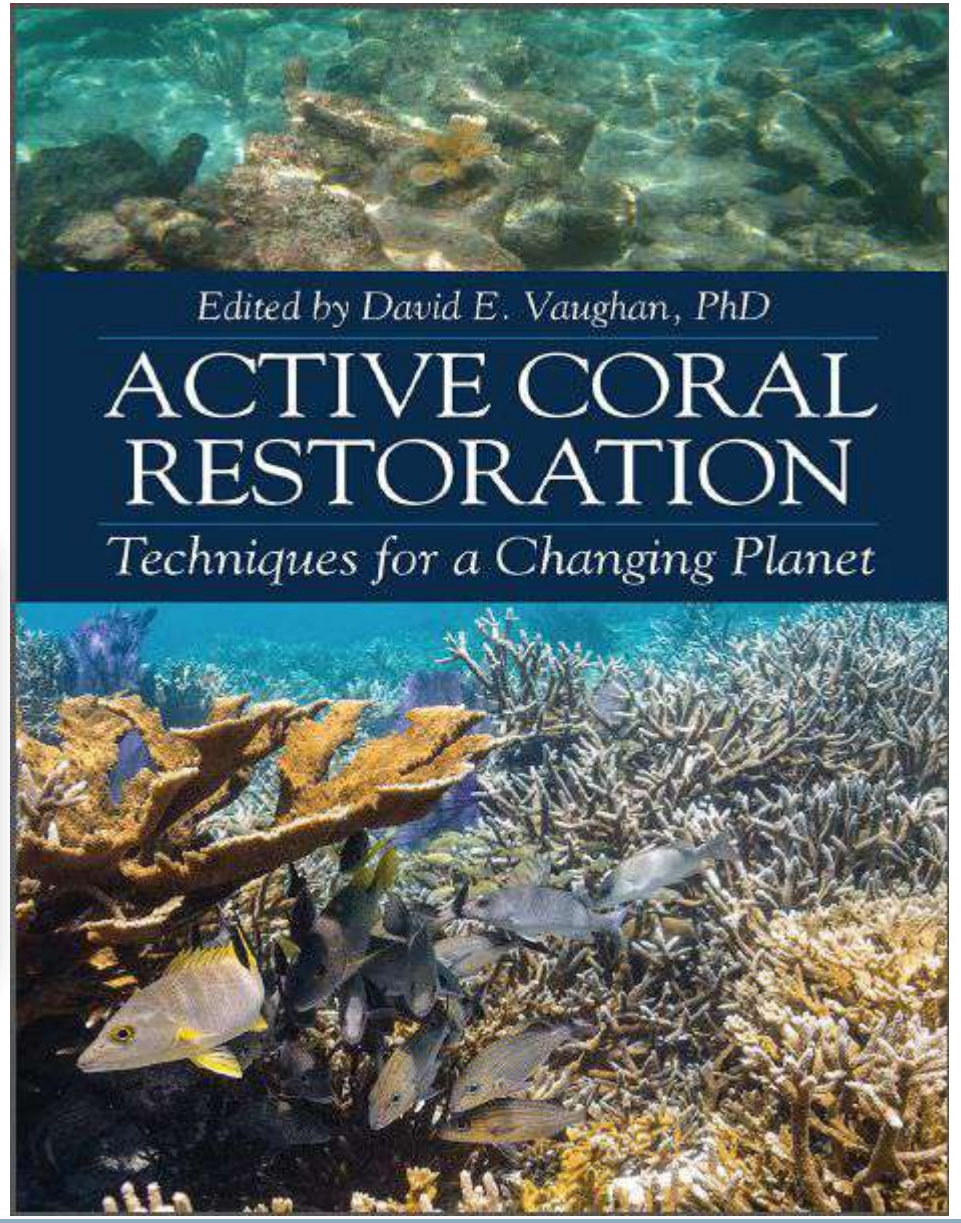
Coral micro-fragmentation

A technique used in coral reef restoration to accelerate the growth of coral colonies by cutting them into very small pieces (micro-fragments), enhancing rapid tissue growth, with fragments potentially growing 25 to 50 times faster than normal. These fragments can then be fused together, creating larger, more resilient colonies and speeding up reproduction and reef-building.

coral micro-fragmentation

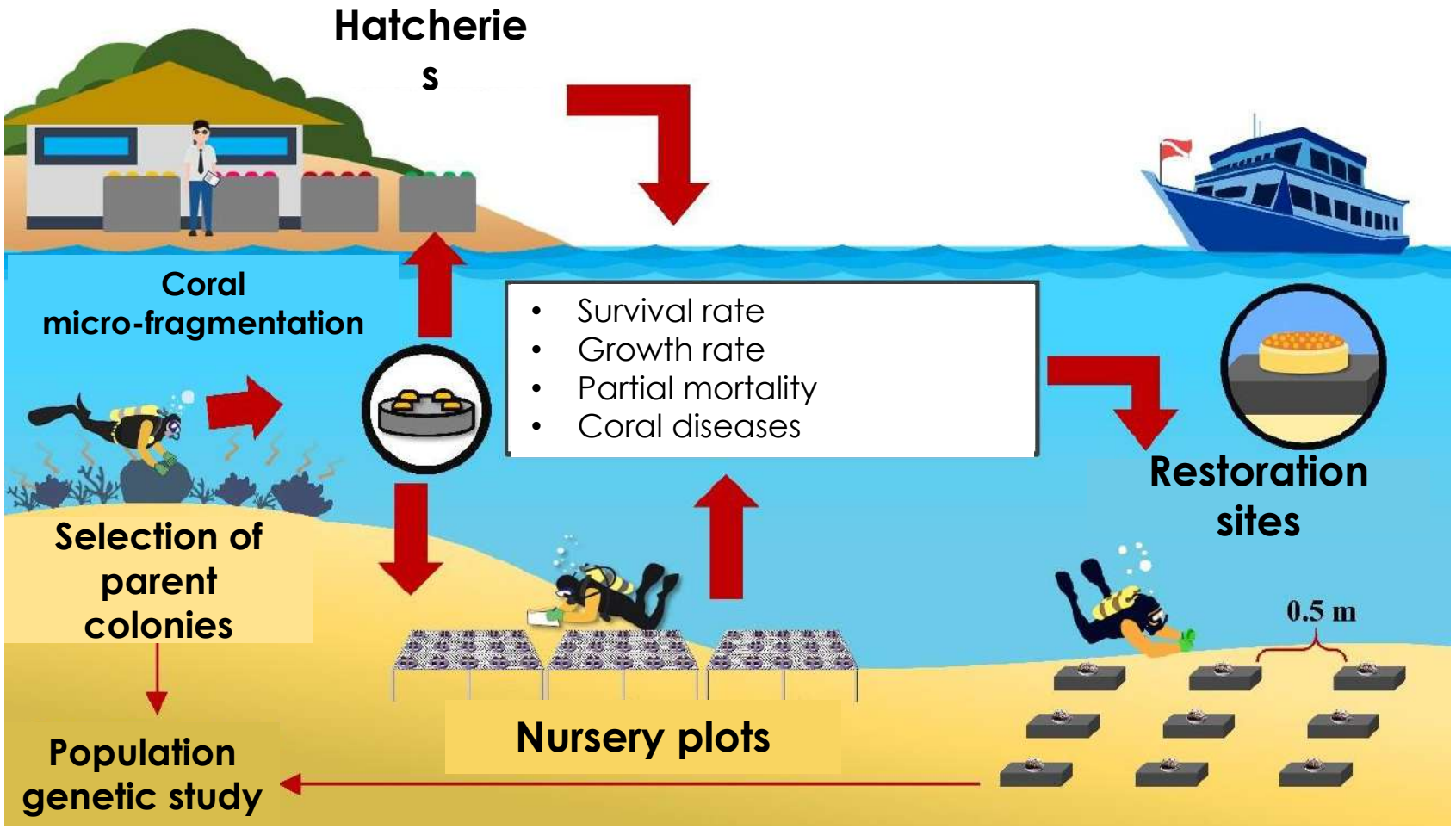
coral colony fusion

This is the first coral reef restoration in Thailand that applies coral micro-fragmentation.

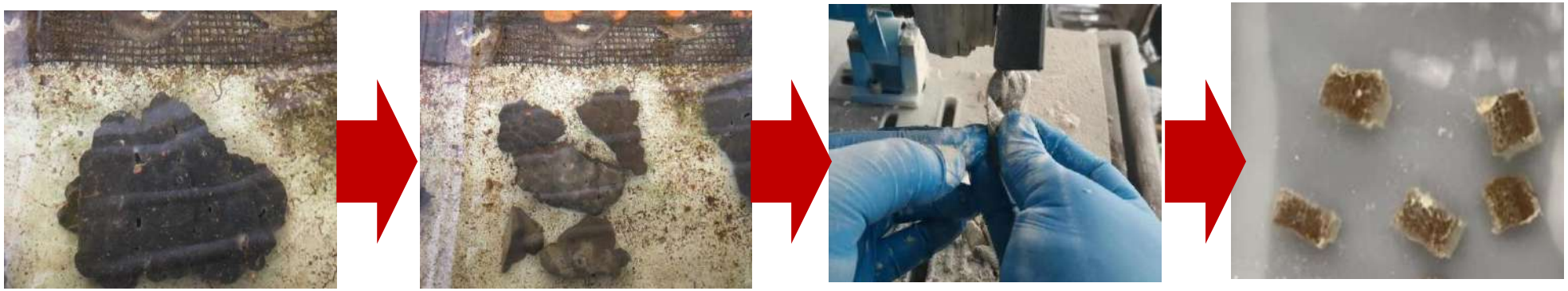


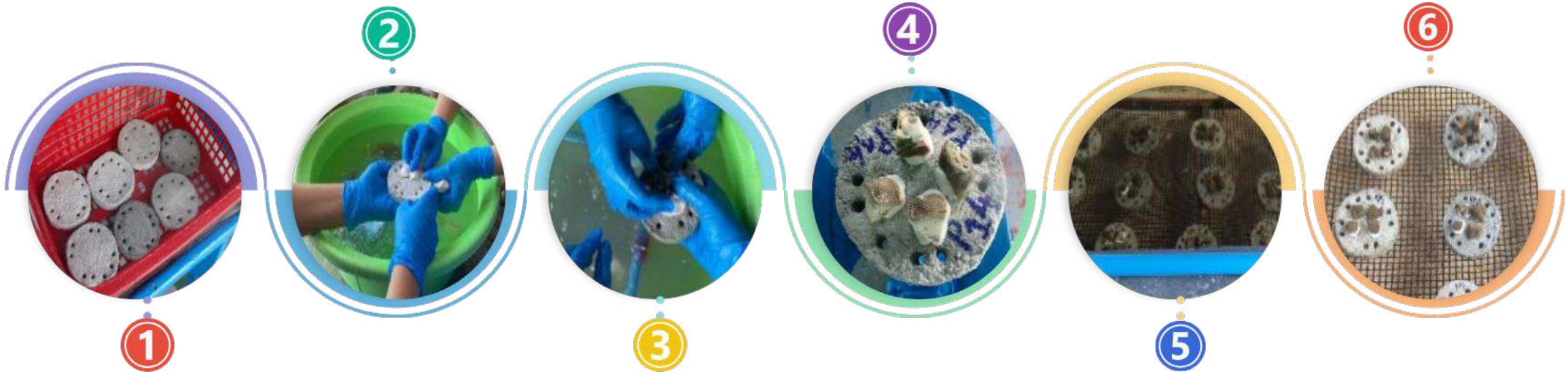
Coral micro-fragmentation

- Survey sources of coral broodstock, nursery plots in coral reefs, and coral reef restoration sites.
- Establish nursery plots in coral reefs and select coral species
- Create coral reef restoration areas using small coral fragments that have been selected and grown to form colonies in hatcheries and nursery plots in coral reefs.
- Study environmental factors in hatcheries, nursery plots in coral reefs, and coral reef restoration sites.
- Study the genetic diversity of coral populations in natural coral reefs and in coral reef restoration sites.

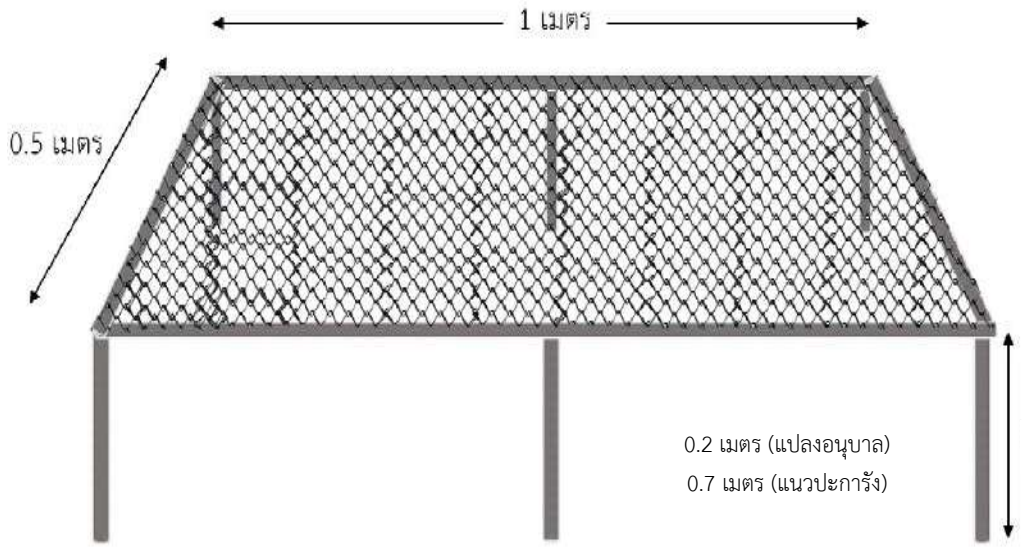


Coral micro-fragmentation – preparation of coral micro-fragments





Coral micro-fragmentation – hatcheries and nursery grounds



Hatchery 1
(*Porites lutea*)

Hatchery 2
(*Leptastrea purpurea*)

Hatchery 3
(*Galaxea fascicularis*)

Hatchery 4
(*Favites abdita*)

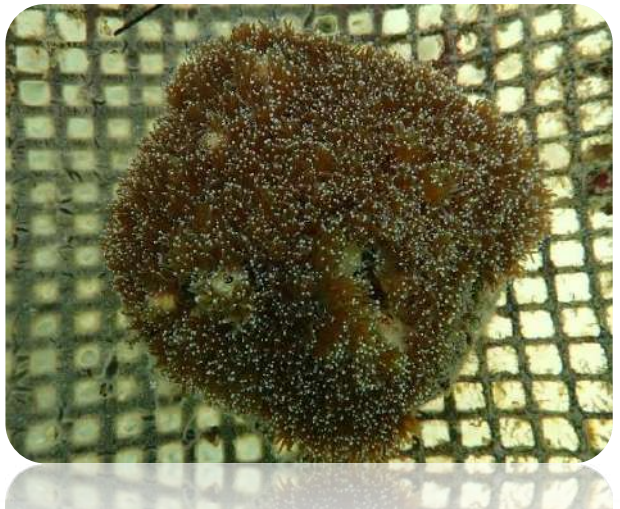
Coral micro-fragmentation – Preliminary results

Survival rate of coral micro fragments in hatcheries and nursery plots

- Survival rates:
  - *Porites lutea* >80%
  - *Favites abdita* >94 %
  - *Galaxea fascicularis* >84 %
  - *Leptastrea purpurea* >96 %

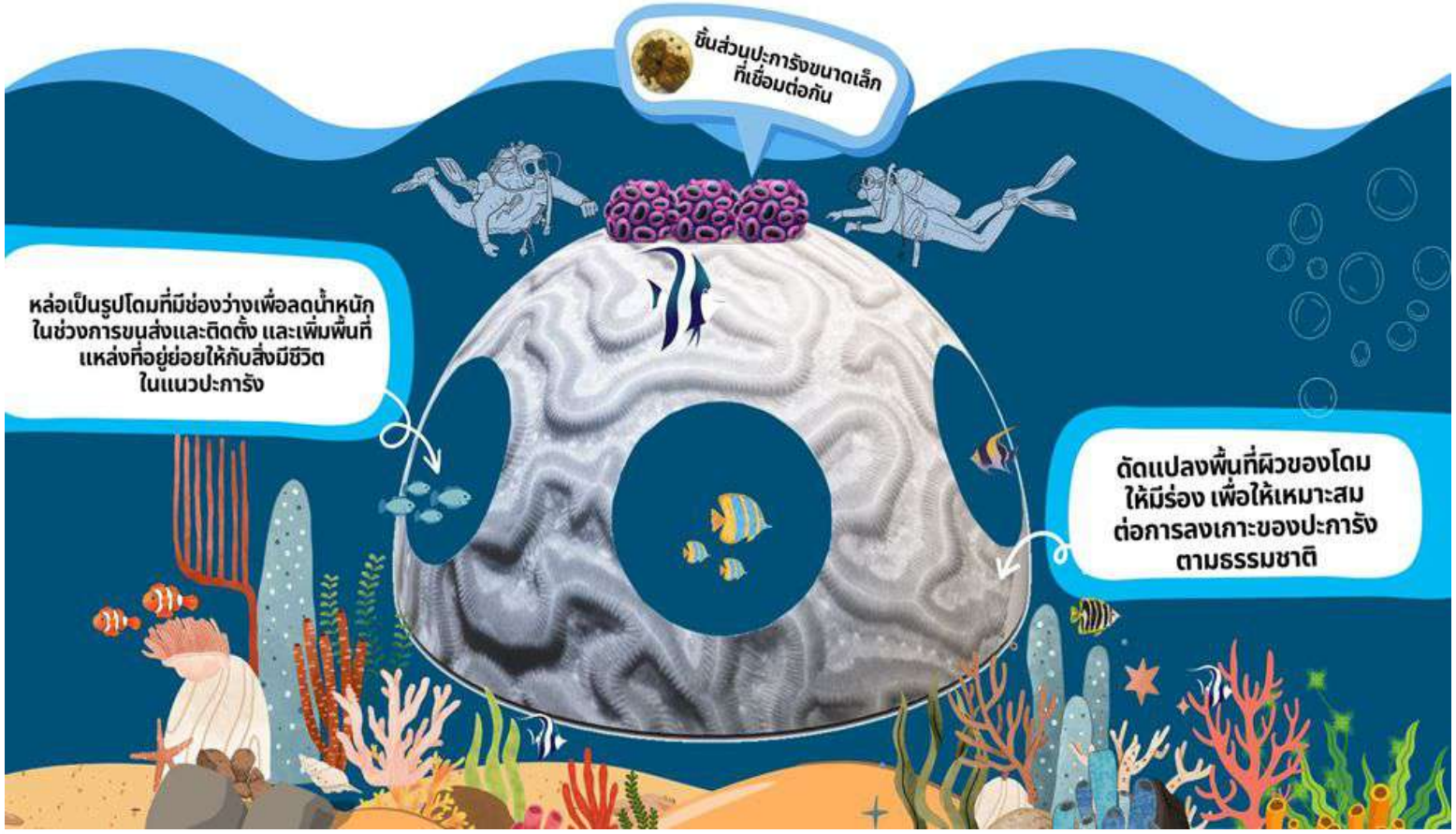
- Growth rates:

✔ 1 cm wide	❖ 0.78±0.27 cm^2/month
✔ 2 cm wide	❖ 0.52±0.39 cm^2/month
✔ 3 cm wide	❖ 0.48±0.24 cm^2/month



Coral micro-fragmentation- site restoration

Transplanting fused colonies to restoration sites



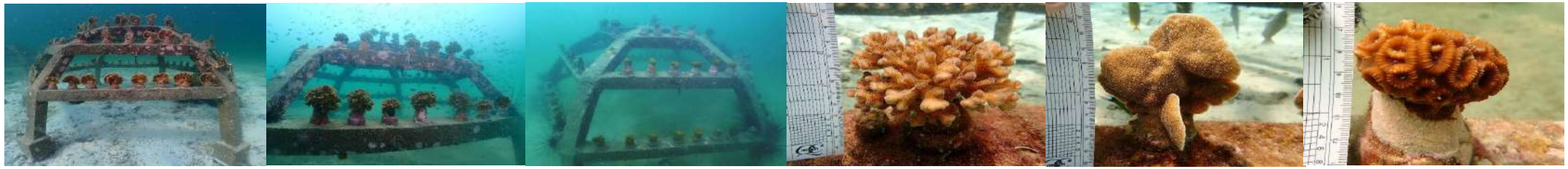
Development of coral nurseries for selection of high stress-tolerant coral fragments from shallow reef flats

- **Corals from the shallow reef flat are resilient and adapted to survive in environments with high temperatures, intense light, and high ultraviolet radiation.**
- **Selecting coral parent colonies from the shallow reef flat is therefore crucial for coral reef restoration projects in Thailand.**

Target	**Development of coral nurseries for selection of high stress-tolerant coral fragments from shallow reef flats**

Objectives

- To create a prototype coral nursery plot for a coral reef restoration project by selecting coral fragments that are resilient to high-stress environmental conditions from coral parent colony in the shallow reef flat.
- To study the biology, physiology, and ecology of corals in the nursery plot and in the parent colony areas in the shallow reef flat.
- To establish a learning resource for marine ecotourism within the national park.
- To create a participatory process for natural resource and environmental management between government agencies and other sectors in order to advance high-level coral biology research and develop a new generation of researchers in the field of marine biology.



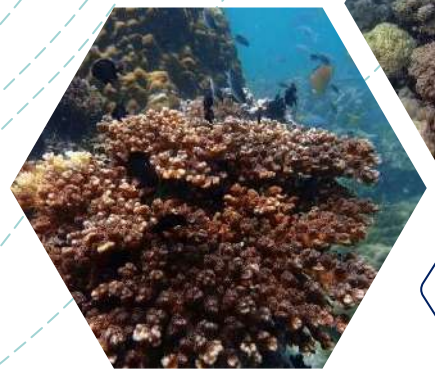
Selection of coral fragments from parent colonies in the shallow reef flat and reef slope

- No partial colony mortality
- No bleaching
- No coral borers
- No coral diseases

Ko Rang Kachiu

Dipsastraea favus

Porites lutea



Pocillopora acuta

Ko Ngam Yai

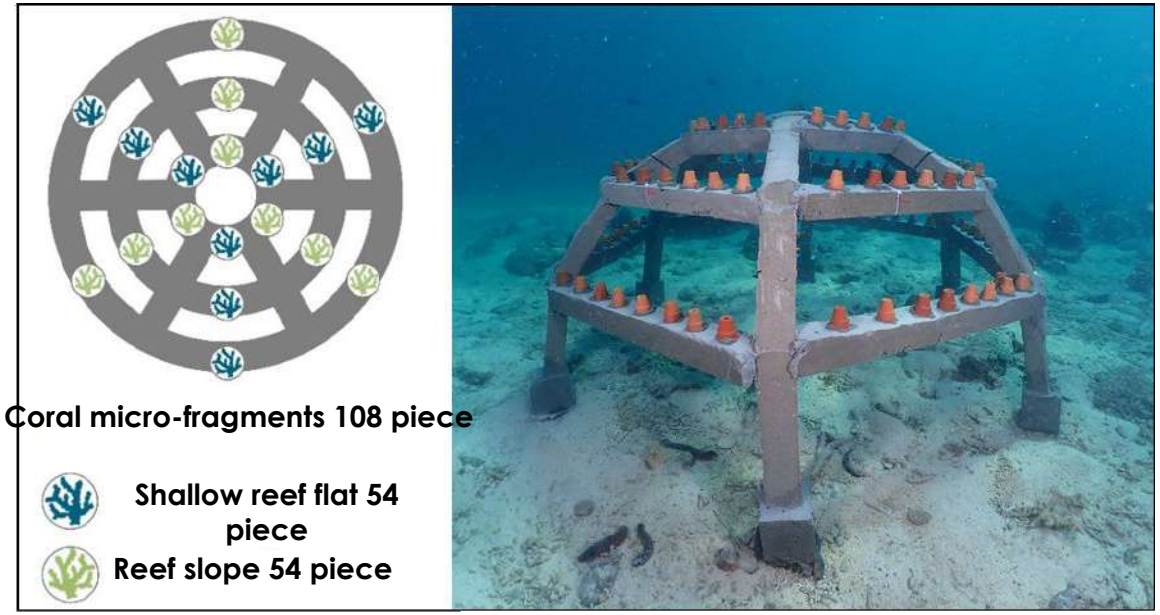
Pavona decussata

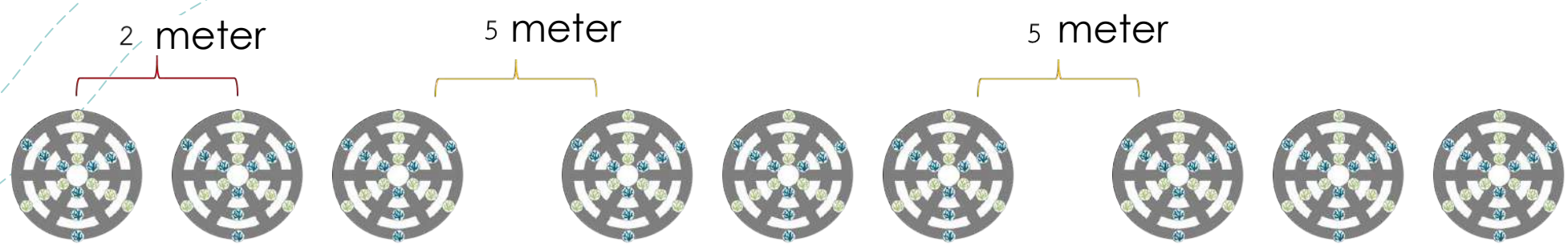
Porites lutea

Pocillopora acuta

Create an environmentally friendly coral nurseries

- Artificial reefs were designed as dome-shaped concreates with hole inside the dome shape to reduce weight and increase the space for marine organisms such as fish.
- There are 9 domes at each study site (Ko Rang Kachiu and Ko Ngam Yai)
- Each type of coral fragment was approximately 3 centimeters in size, are placed on a clay cup attached to the dome.
- Each study site contained 972 coral fragments.





Establishment of a prototype of coral nursery plot at each study site

Coral fragments from parent colonies in the shallow reef flats and reef slopes

Ko Rang Kachiu


(*Pocillopora acuta*)


(*Dipsastraea favus*)


(*Porites lutea*)

Ko Ngam Yai


(*Pocillopora acuta*)


(*Pavona decussata*)


(*Porites lutea*)

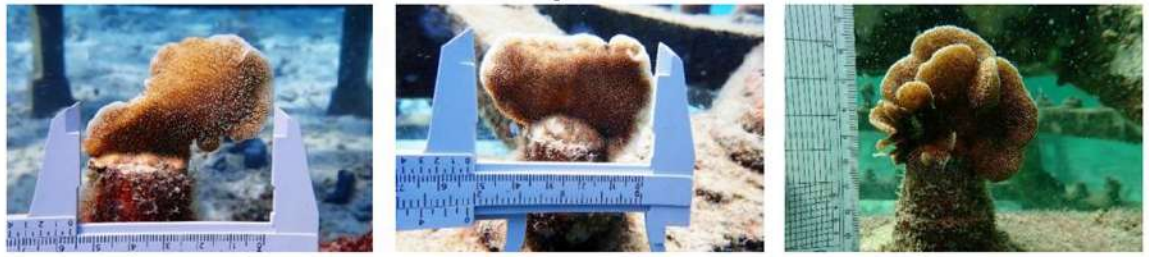
Monitoring the growth rates of coral fragments in the nursery plots

after 2 months | after 6 months | after 1 year

Porites lutea

after 2 months | after 6 months | after 1 year

Pocillopora acuta



after 2 months | after 6 months | after 1 year

Pavona decusata

after 2 months | after 6 months | after 1 year

Dipsastraea favus

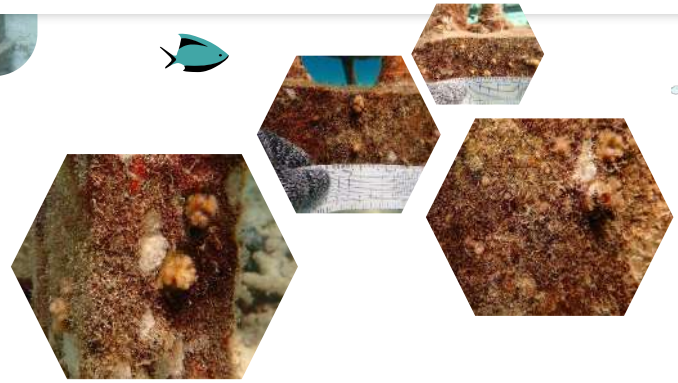
- Coral fragments in the shallow reef flat exhibited higher growth rate than in the reef slope.
- No bleaching of coral fragments was found.
- No disease was found in coral fragments
- Partial mortality of coral tissue with only a few fragments

Coral recruitment on dome-shaped coral nurseries

Coral recruits were observed on the dome-shaped coral nurseries, with most settling on the vertical surfaces of the prototype of nursery plots at both Ko Rang Kachiu and Ko Ngam Yai.

Pocillopora acuta was the dominant coral recruit on the dome-shaped coral nurseries at both Ko Rang Kachiu and Ko Ngam Yai.

The density of coral recruits on dome-shaped coral nursery at Ko Rang Kachiu, was higher than that at Ko Ngam Yai.



Development of coral nurseries for selection of high stress-tolerant coral fragments from shallow reef flats

Summary

Sallow reef flat

Hight light intensity and ultraviolet

Exposure during low tides

High temperatures

Reef slope

Learning resources for marine ecotourism

Tolerant coral breeders for high temperatures and other stresses

Analysis on
- Environmental factors
- Biology/physiology/ecology

Pilot coral nursery
- Selected stress-tolerant coral fragments
- No partial mortality
- No bleaching

Transplantation of selected corals from a coral nursery

Coral reef restoration site

SUMMARY

- The success of coral micro-fragmentation and coral fragment selection in Thailand underscores the potential for synergy between marine conservation and nature-positive tourism.
- The term "nature-positive" refers to actions that halt and reverse nature loss, enhancing ecosystem services while benefiting human well-being.
- In this context, coral restoration contributes to biodiversity recovery and climate resilience, while tourism generates economic incentives and awareness to support ongoing conservation.

THANK YOU

Wichin Suebpala

Marine Biodiversity Research Group

Department of Biology, Faculty of Science,
Ramkhamhaeng University, Bangkok, Thailand

E-mail: wichin.s@gmail.com