Reinventing Reefs in the Anthropocene: Restoring Ecosystem Services and Scaling up Blue Economy Outputs

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Reef Rescuers (RR2.0)
Blue Economy Knowledge Initiative (BEKI)

2015/03/14

How can we bring a dead reef…

…back to life?

Why are coral reefs important?

DID YOU KNOW?
CERTAIN CORALS ONLY GROW A **QUARTER OF AN INCH ANNUALLY**

THE GREAT BARRIER REEF **BEGAN FORMING** **20,000** YEARS AGO

0.2% OF THE OCEAN FLOOR IS COVERED BY CORAL REEFS

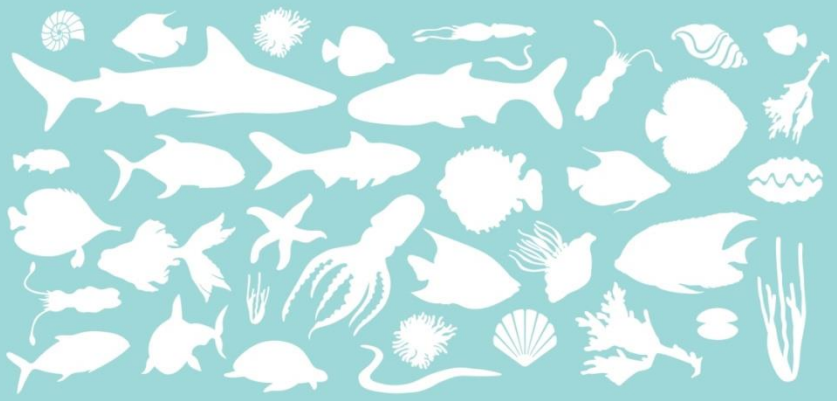
25% OF MARINE ANIMALS ARE SUPPORTED BY CORAL REEFS

● MOST THREATENED REEFS

SEVENTY-FIVE PERCENT
OF THE WORLD'S REEFS ARE THREATENED.

NATIONAL AQUARIUM | aqua.org

8 MILLION
CORAL REEF SPECIES HAVE YET TO BE DISCOVERED



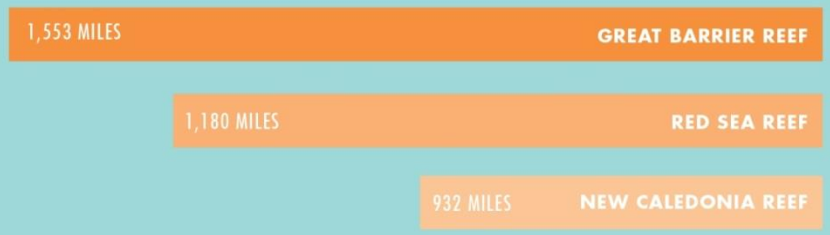
WHAT IS THREATENING CORAL REEFS?


OVERFISHING


WARMING WATERS


POLLUTION

LENGTH OF THE WORLD'S LARGEST REEFS



The problem in Seychelles

1998 El Niño-IOD: The coral killer

2004 Tsunami: Coastal erosion

Before

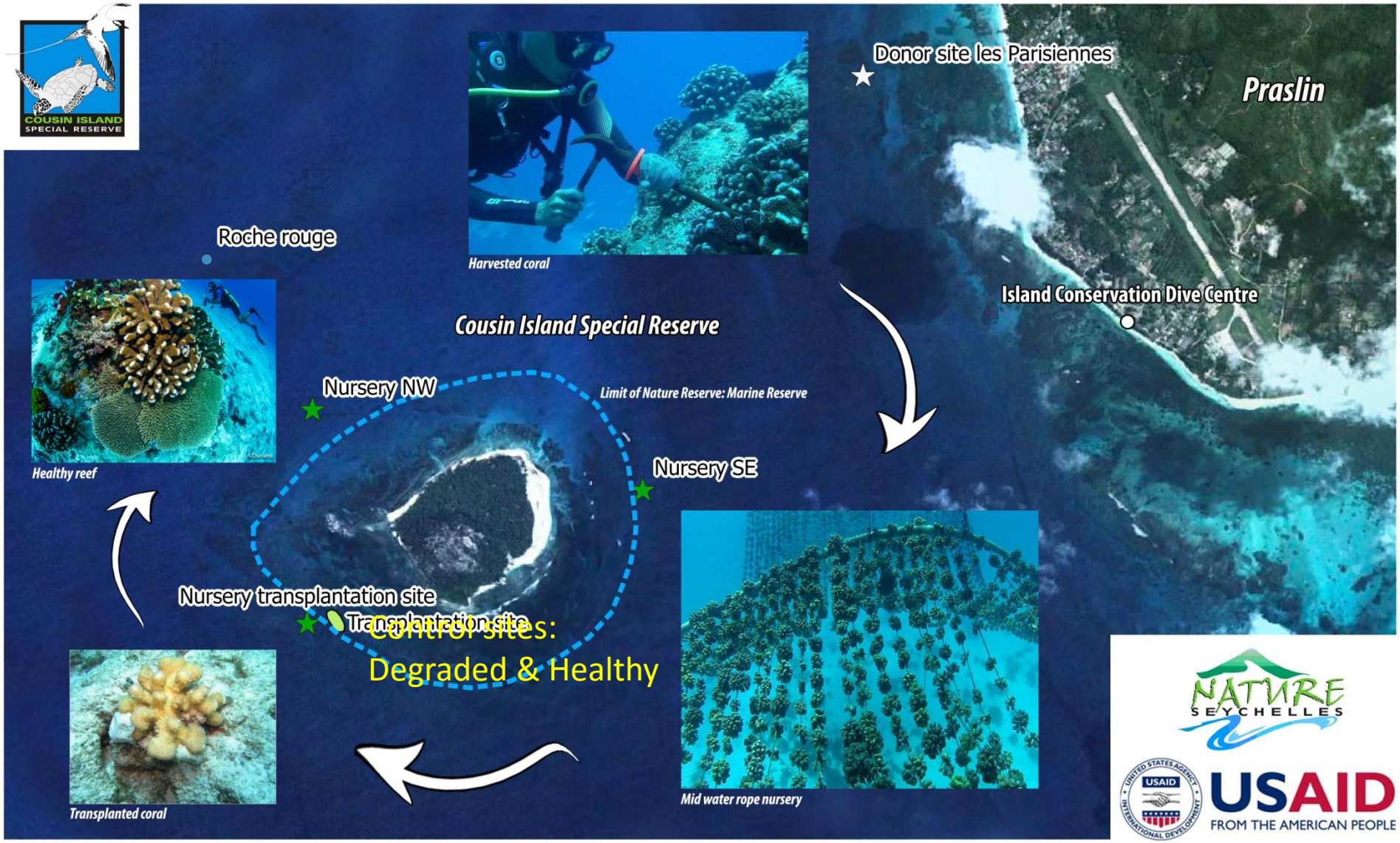
After

Coral Reef

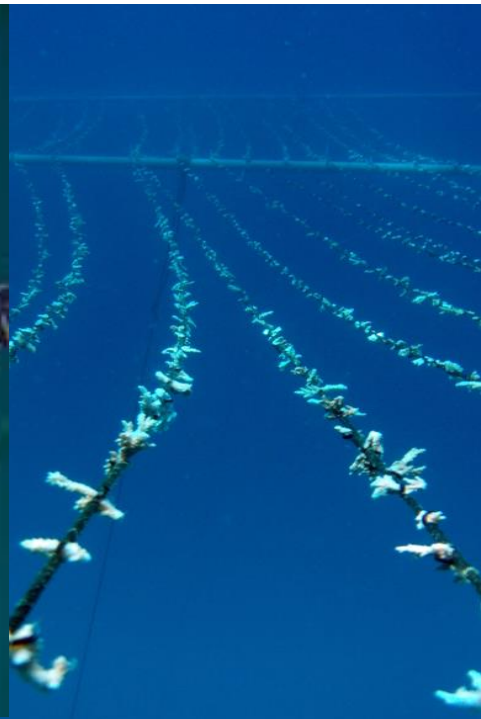
Dead Coral Rubble

The Solution:

Restoring reefs adapted to climate change



The Birds and the Corals: Novel Habitats to restore Ecosystem Services in the time of Climate Change



Coral reef gardening

Stage one:

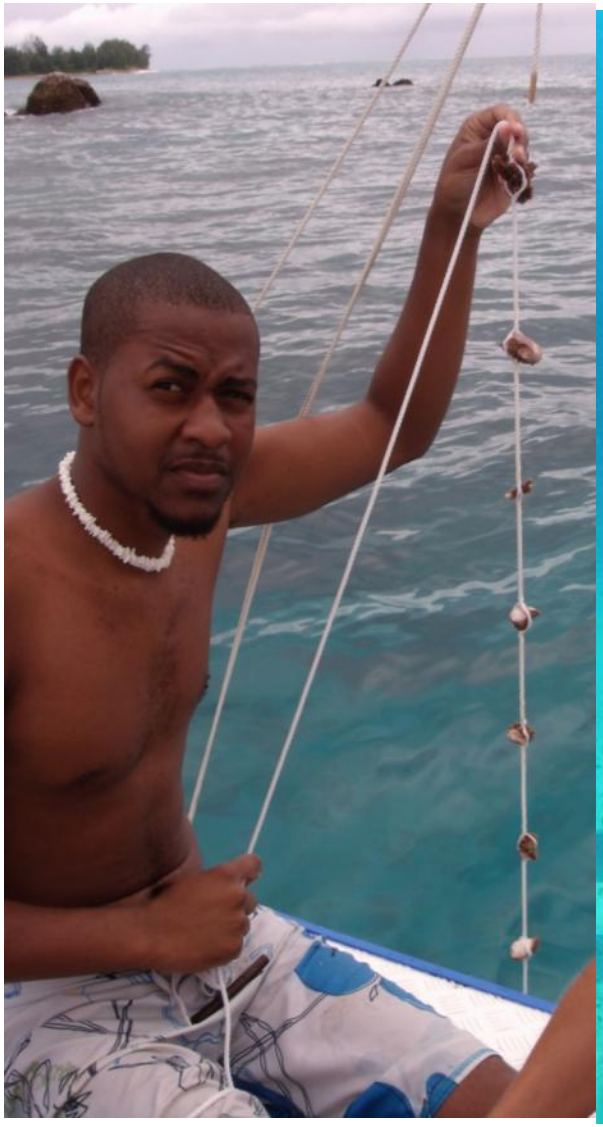
Establishing a coral nursery in a sheltered area

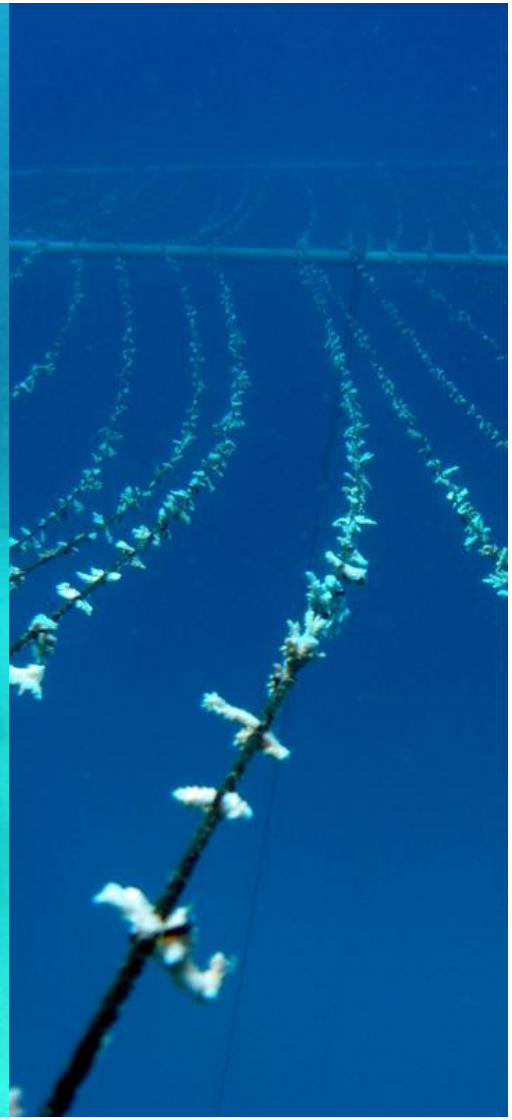
Stage two:

Transplanting colonies from nursery to degraded sites

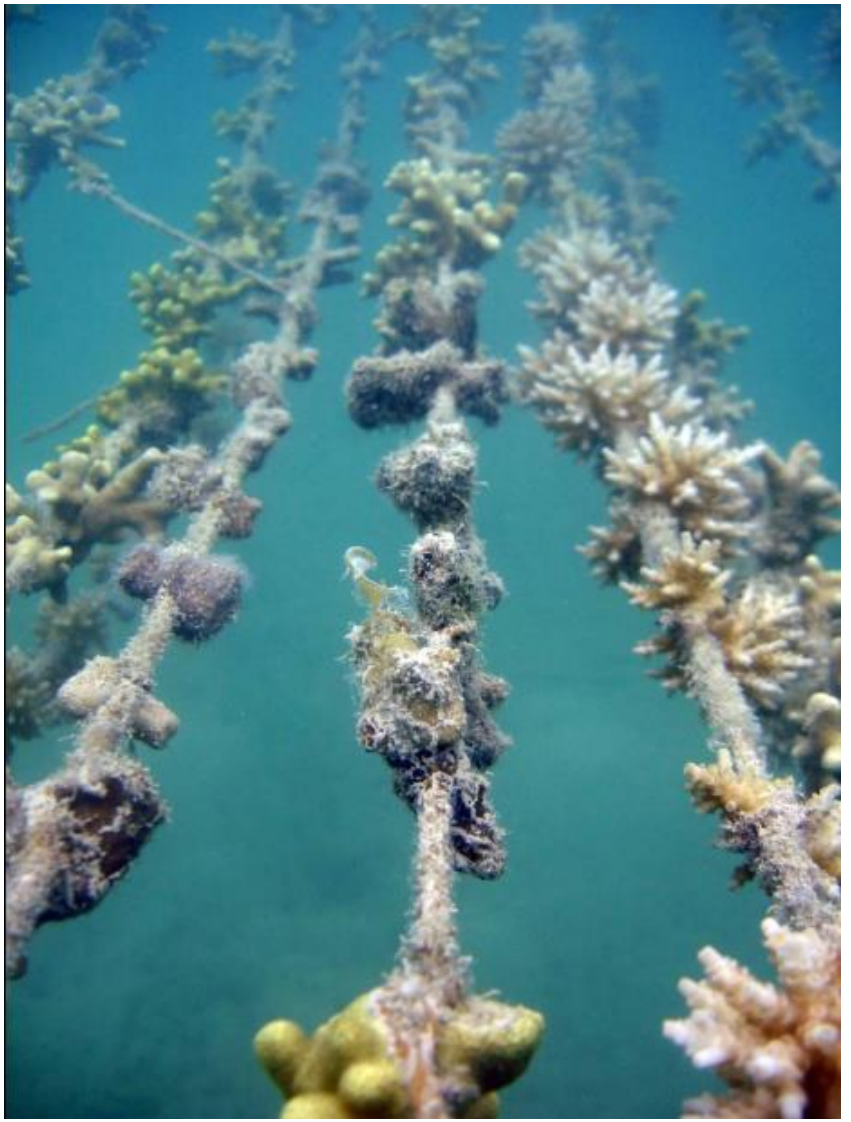
Harvesting species that survived bleaching

Grow corals in underwater nurseries





Mariculture to sizes suitable for transplantation



Harvest nursery corals and cement onto degraded reef

Govts. and Region take note:
largest, most bio-diverse coral restoration project in the world

- 9 rope nurseries set up, totaling 40,801 initial coral fragments
- 3 net nurseries set up, totaling 1,024 coral fragments
- 86 donor & control colonies monitored
- 27,431 nursery-grown corals transplanted (~ **70 % survival process**, after 2 trop. storms and disease)
- 5,225 m^2 of coral reef restored
- 34 coral species transplanted in total : 90 % of them of 8 spp
- 3-year project

Biodiversity: 34 coral species transplanted

Fast growers = “The Hare”

Branching/Tabular

90 % of all coral transplants = 8 species

Acropora hyacinthus, A. cytherea, A. vermiculata,

A. abrotanoides, A. appressa,

B. Pocillopora indiania, P. damicornis, P. grandis

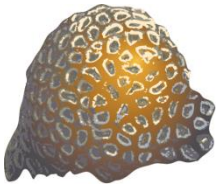
Stylophora pistillata, S. subseriata

Slow growers = “The Tortoise”

Massive/submassive

Acanthastrea brevis, Astreopora myriophthalma, Coscinaraea monile, Cyphastrea sp., Dipsastraea lizardensis, Favites vasta, Galaxea fascicularis, Goniastrea edwardsi, Goniopora tenuidens, Hydnophora microconos, Lobophyllia hemprichii, Astrae curta, Paramontastraea serageldini, Pavona decussata, P. explanulata, Platygyra acuta, Porites lobata

Encrusting



Echinophyllia aspera, Echinopora hirsutissima, Favites pentagona, Leptastrea purpurea, Leptoseris incrustans, Psammocora haimiana, Turbinaria irregularis

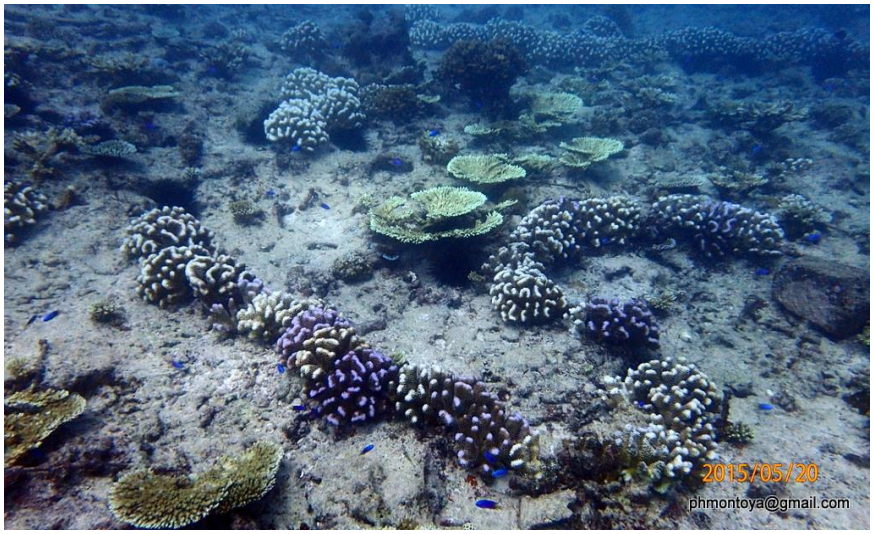
Today

Healthy-Control

Degraded-Control

Transplantation

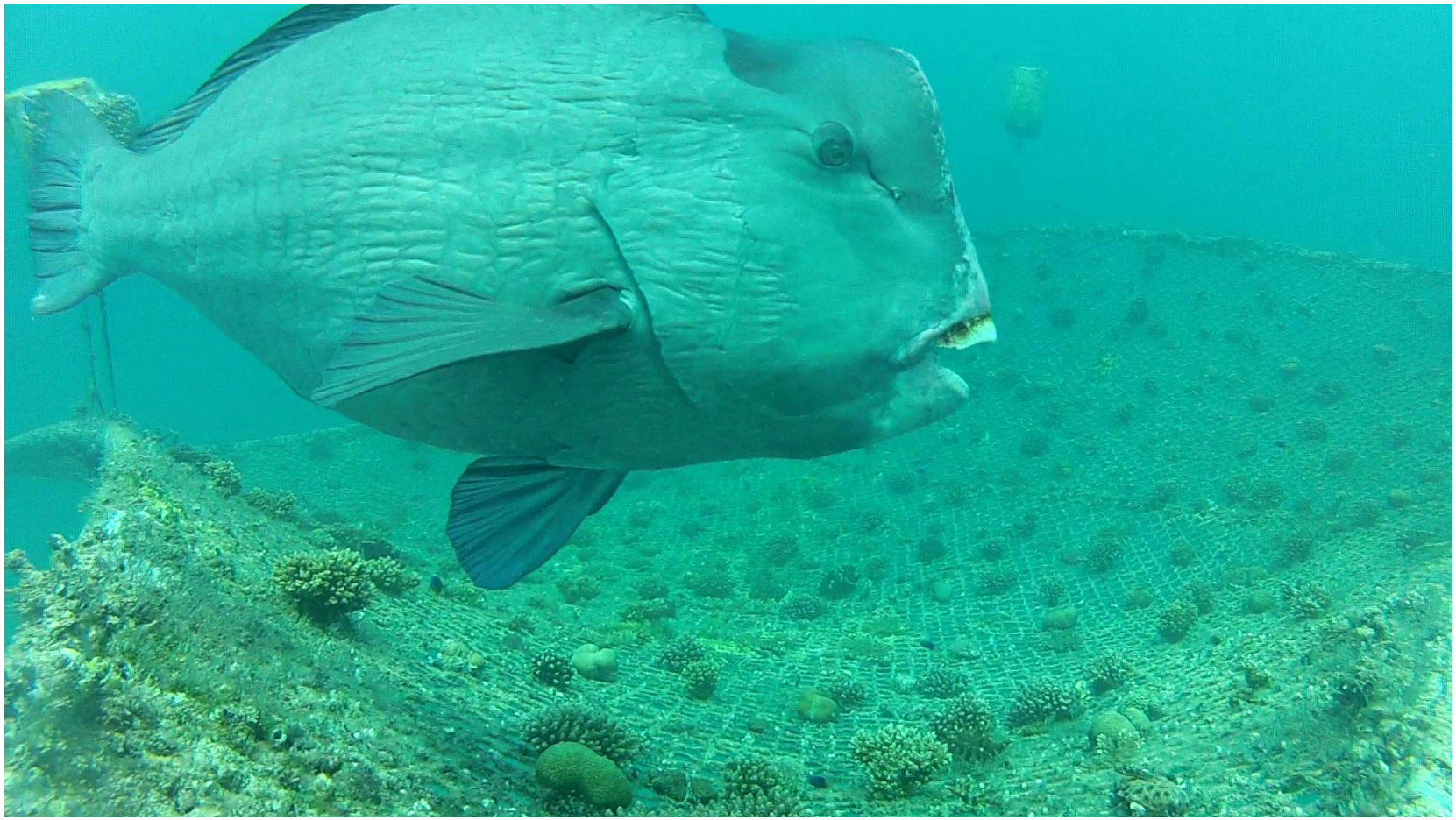
Transplanted site



Happy Birthday

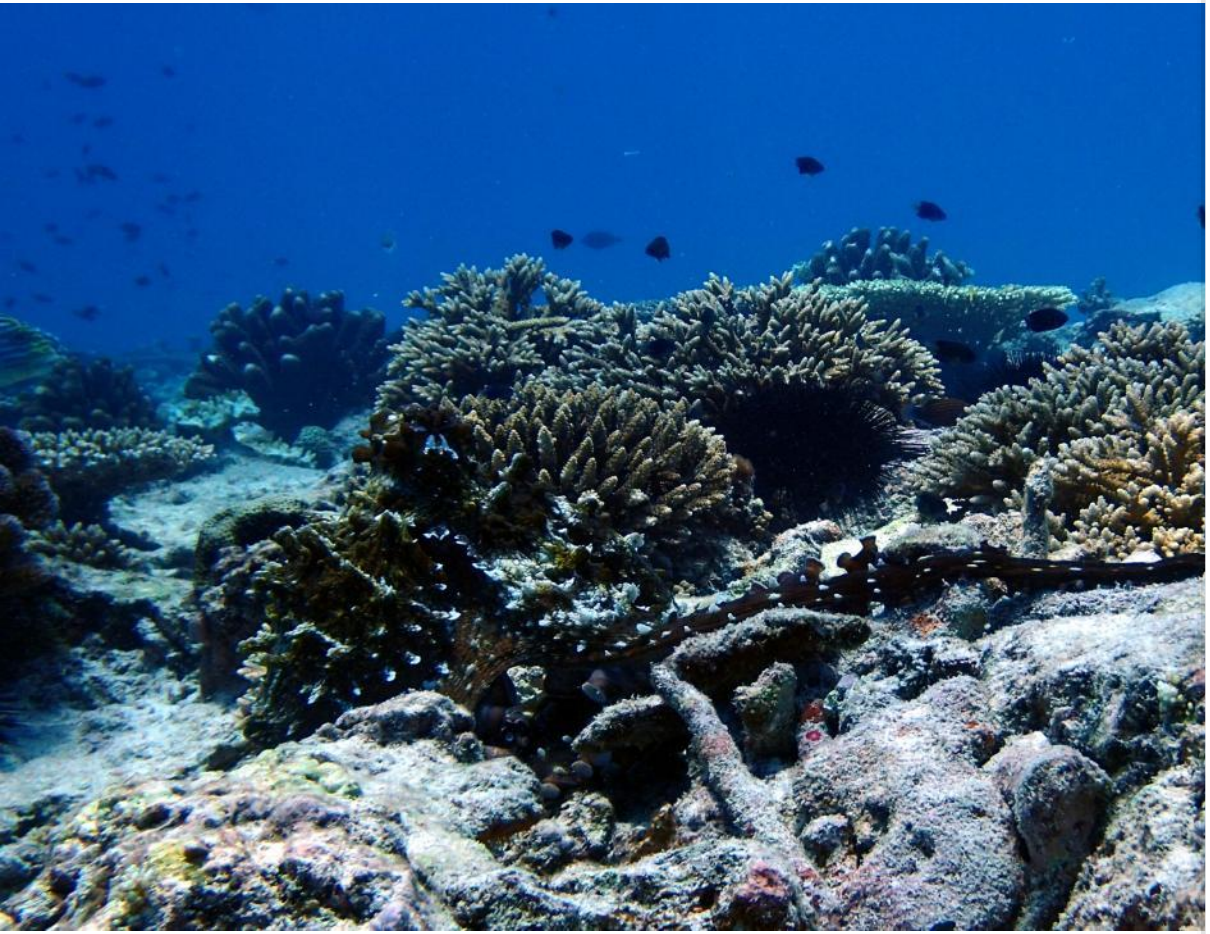
1 year old

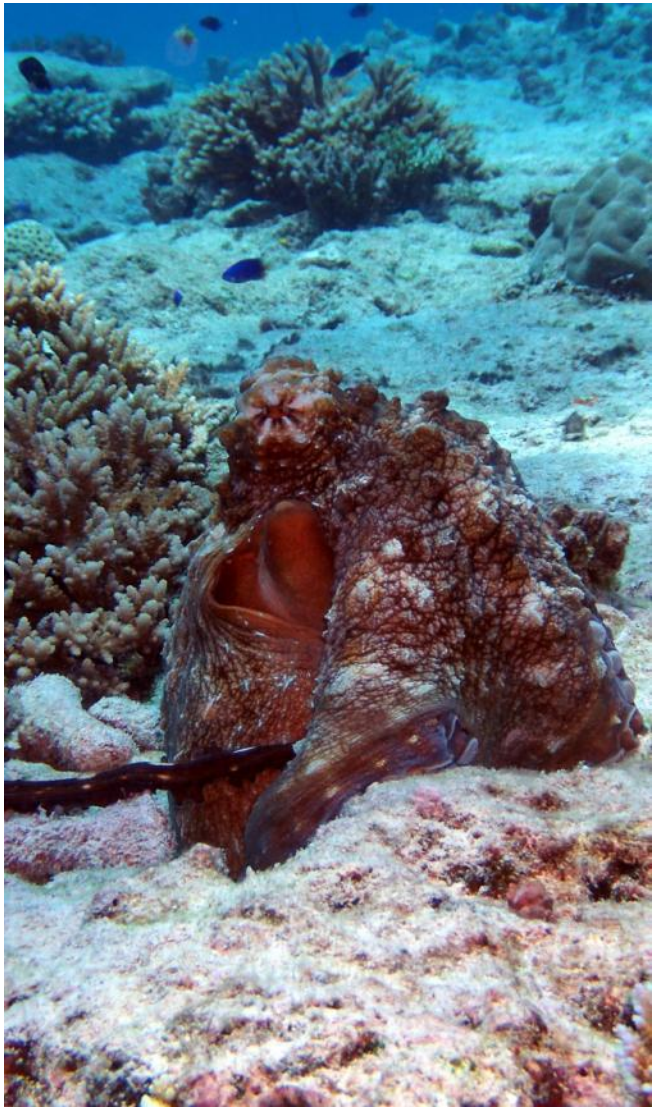
Ecosystem-level restoration



Humphead Parrotfish, *Bolbometopon muricatum*
IUCN status: Threatened

Restoring fishing resources

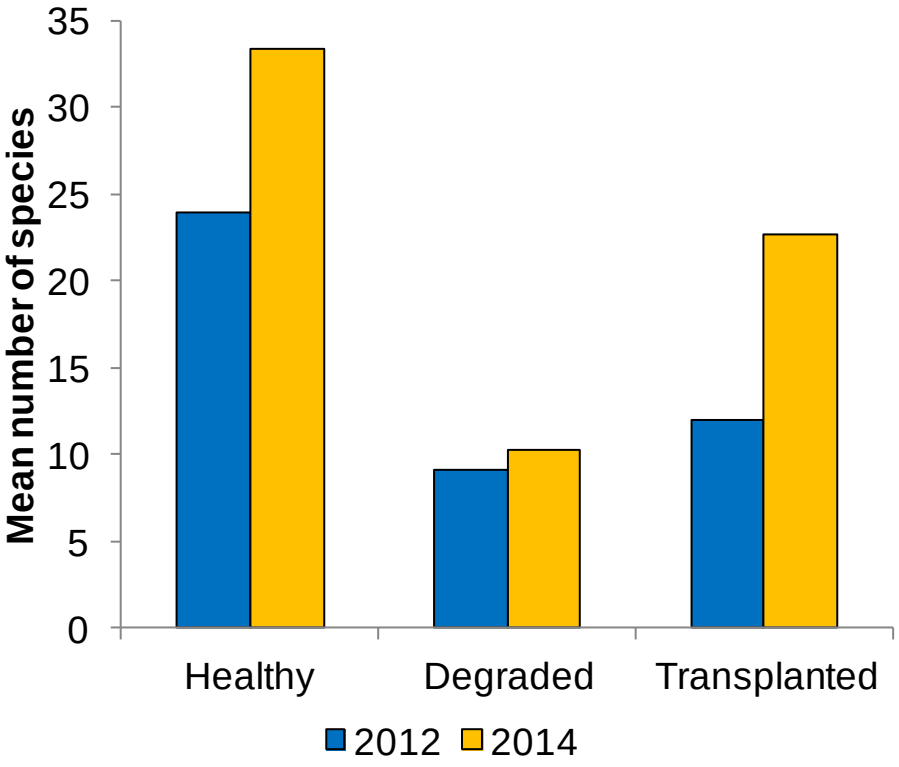




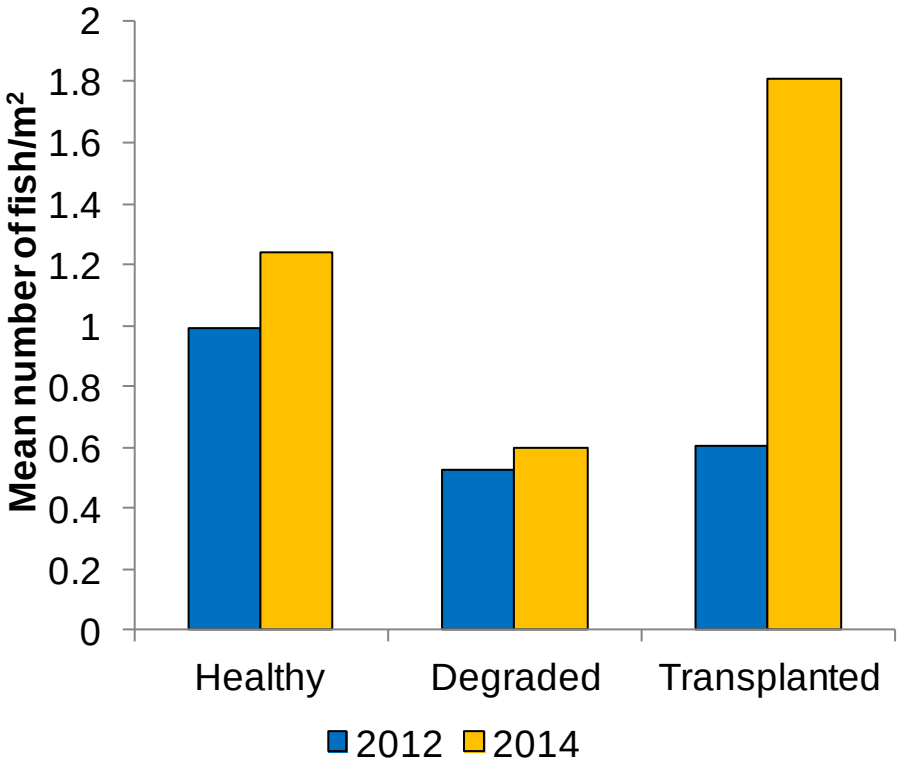
Restoring food webs

Fish before-after coral restoration

Species richness



Abundance



Govts. & Region take note:

Keys to successful large scale coral reef restoration

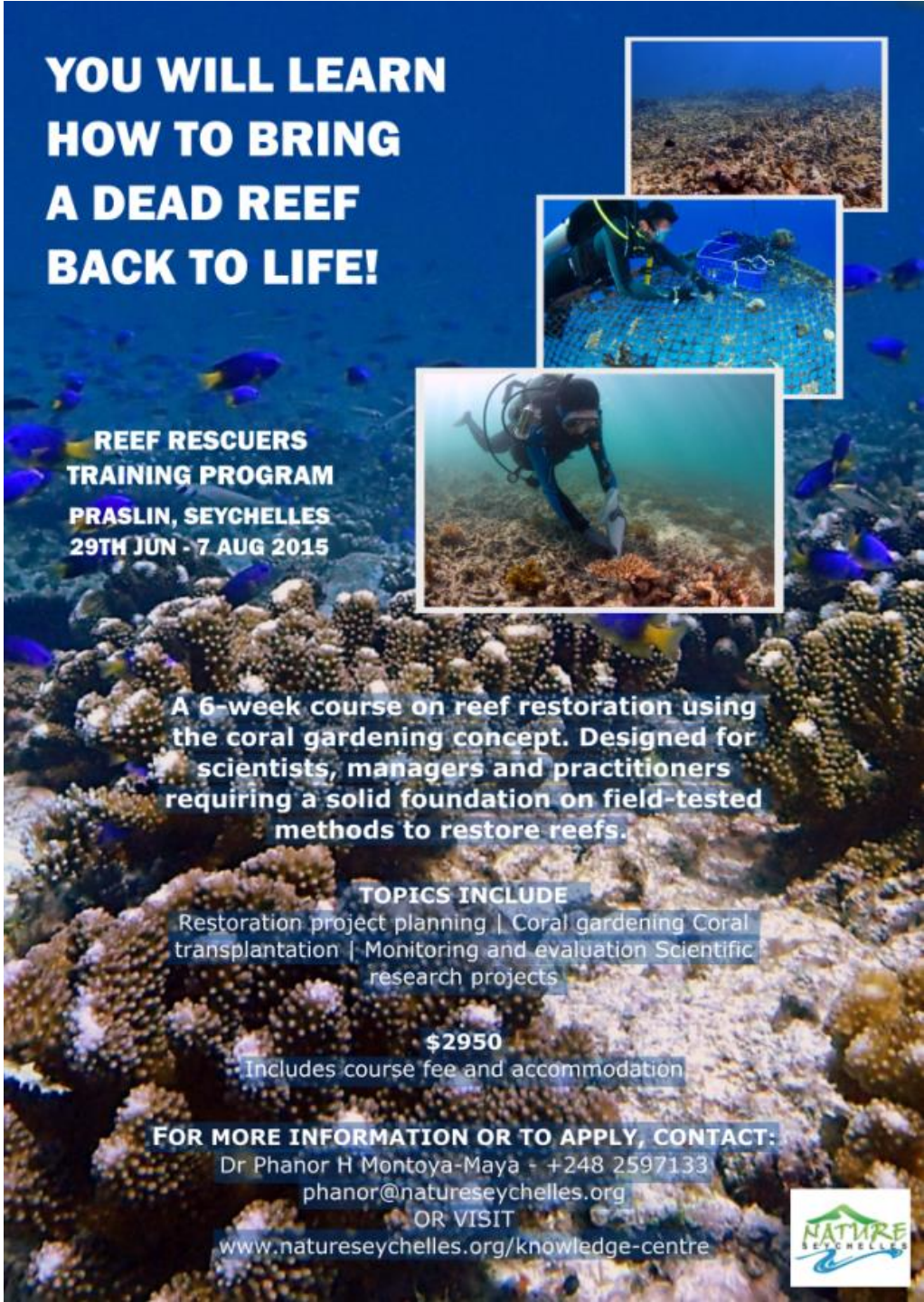
- Science-based restoration ☜
- We scaled up experimental-size technology
- Cost-effective: Locally found materials (recycle, upcycle)
- Highly skilled lead staff and scientific divers (6-10 people/year)
- Dedicated infrastructure: dive boat, SCUBA gear, in situ marine laboratory (Praslin)

Capacity building for science-based reef restoration in the region

RR=35 Scientific divers from 10 countries were trained

INT. TRAINING PROGRAM
8 trainees to start course from: Australia, Mexico, USA, UK, France and Philippines

We have: **Toolkit in coral reef restoration**



Govts. and Region take Note:
Opportunities for Blue Economy
Reef Restoration=R&D=Mainstreaming

"In Seychelles there is already a coral reef restoration programme being run by Nature Seychelles, which is propagating corals and this offers the opportunity for simple knowledge and technology exchange to foster a coral aquaculture enterprise"

From: SRSL 2015, "Seychelles: Developing a Blue Economy Roadmap"

Report Prepared for the Government of Seychelles on Behalf of the Commonwealth Secretariat


Thank You
Contact us: nature@seychelles.net
blueeconomy@seychelles.net
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FROM THE AMERICAN PEOPLE
NATURE
SEYCHELLES

Extra slides

More details about the different steps in the Reef Rescuers project

Coral reef gardening science

Proceedings of 10th International Coral Reef Symposium, 1674-1679 (2006)

A mid-water coral nursery

Shai Shafir [1,2], Jaap Van Rijn[2] and Baruch Rinkevich[1]

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Short communication

Coral nubbins as source material for coral biological research: A prospectus

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Viewpoint

Management of coral reefs: We have gone wrong when neglecting active reef restoration

Baruch Rinkevich *

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Fixed and suspended coral nurseries in the Philippines: Establishing the first step in the "gardening concept" of reef restoration

Lee Shaish [a,b], Gideon Levy [a,b], Edgardo Gomez [c], Baruch Rinkevich [a,*]

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Ecological Engineering 36 (2010) 713–721

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Mid-water rope nursery—Testing design and performance of a novel reef restoration instrument

Gideon Levy [a,b,*], Lee Shaish [a,b], Abraham Haim [b], Baruch Rinkevich [a,*]

Testing the first phase of the 'gardening concept' as an applicable tool in restoring denuded reefs in Tanzania

Nsajigwa E.J. Mbije [a,b,c,*], Ehud Spanier [b], Baruch Rinkevich [c,**]

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Journal of Experimental Marine Biology and Ecology
journal homepage: www.elsevier.com/locate/jembe

Improved sustainable maintenance for mid-water coral nursery by the application of an anti-fouling agent

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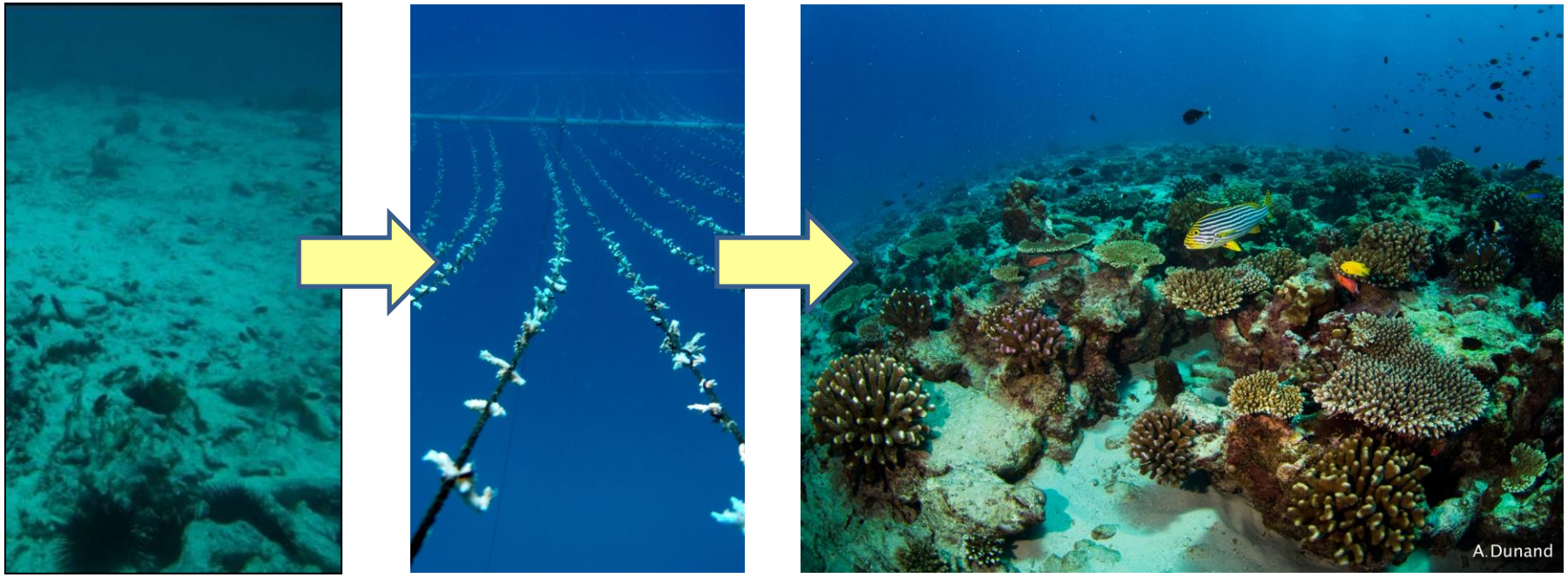
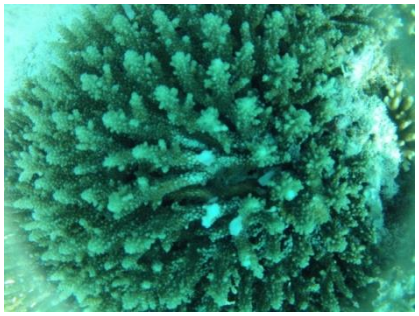
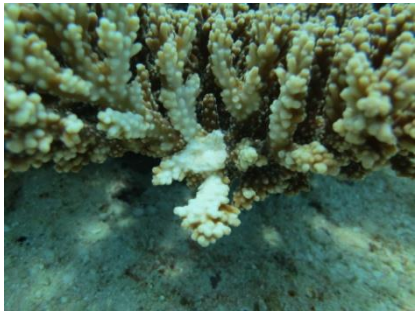
Coral Reef Restoration

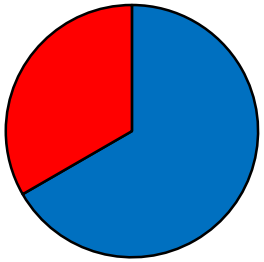


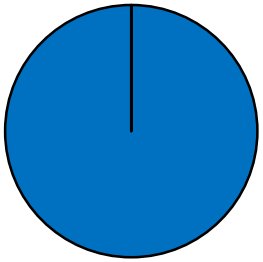
Health monitoring donor sites

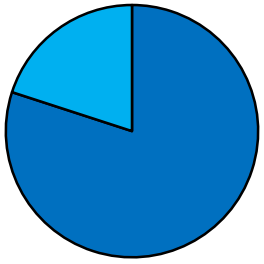
	Donor	Control
A. appressa	126 d; n = 7	92 d; n = 10
A. vermiculata	169 d; n = 5	400 d; n = 7
A. lamarki	378 d; n = 8	306 d; n = 6

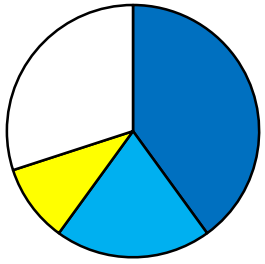


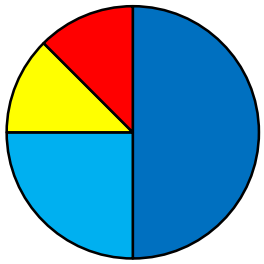


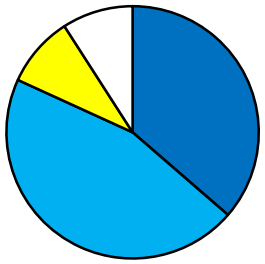












Healthy

100%

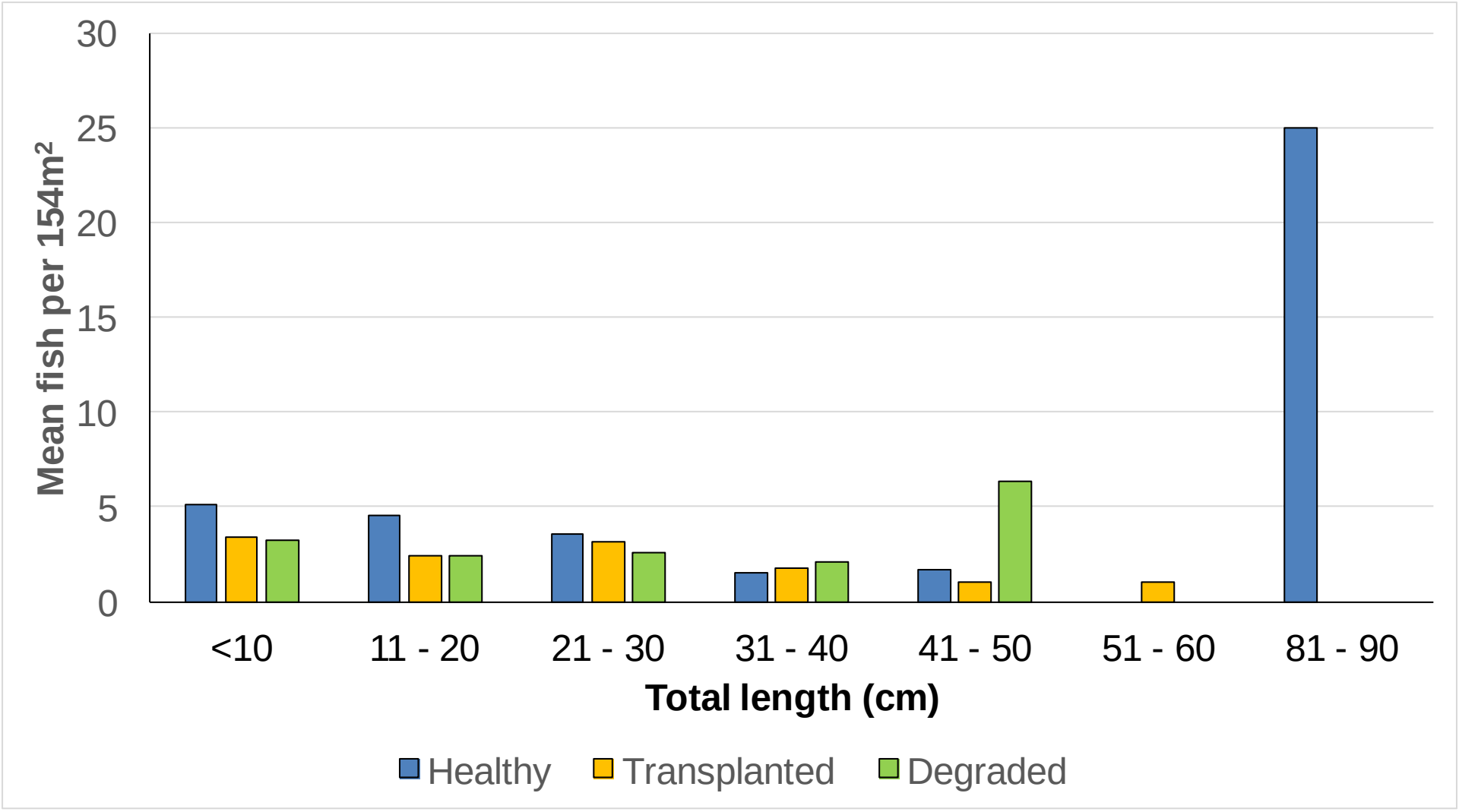
75-99 %

50-74 %

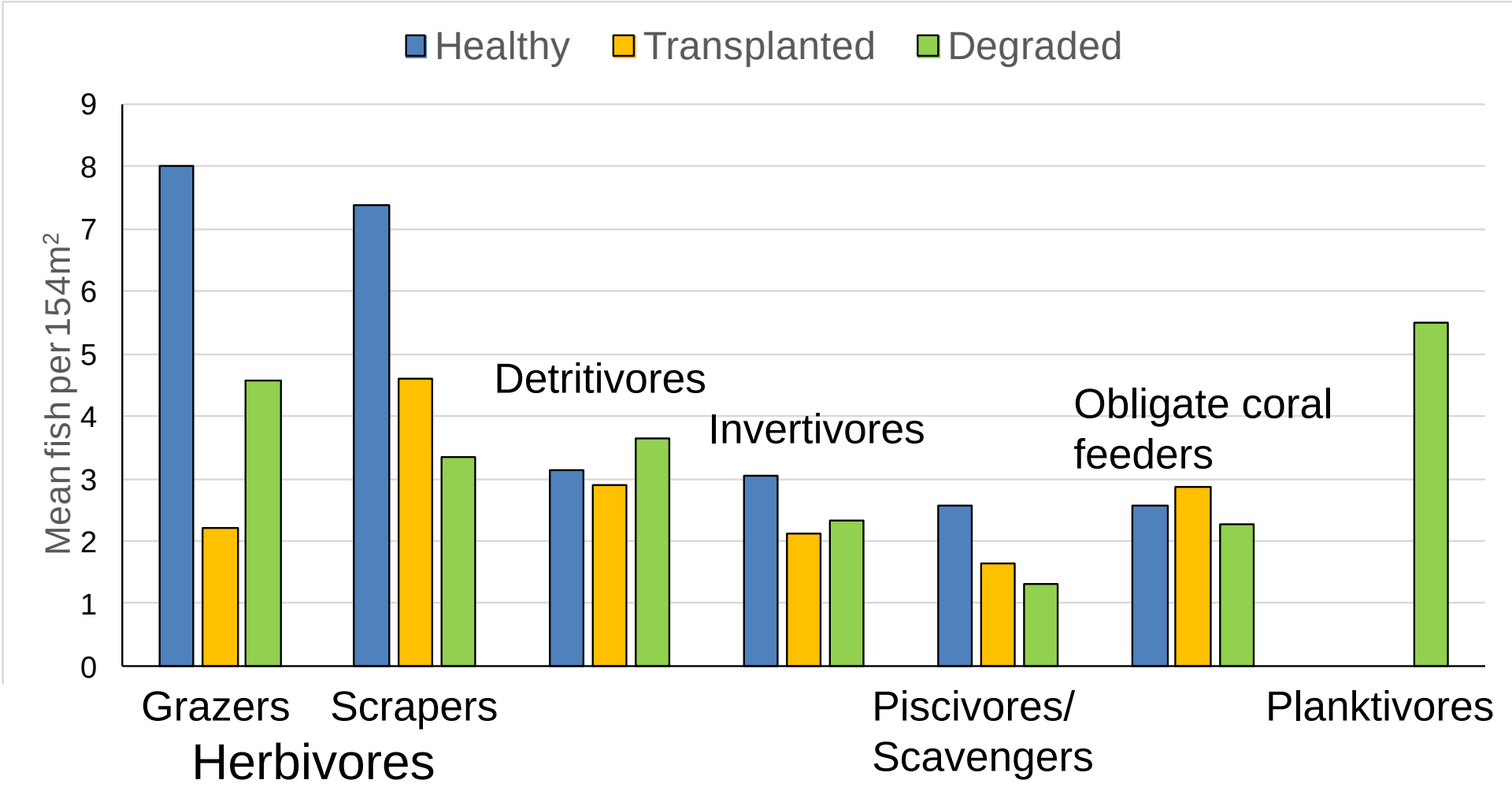
Dead

Not Found

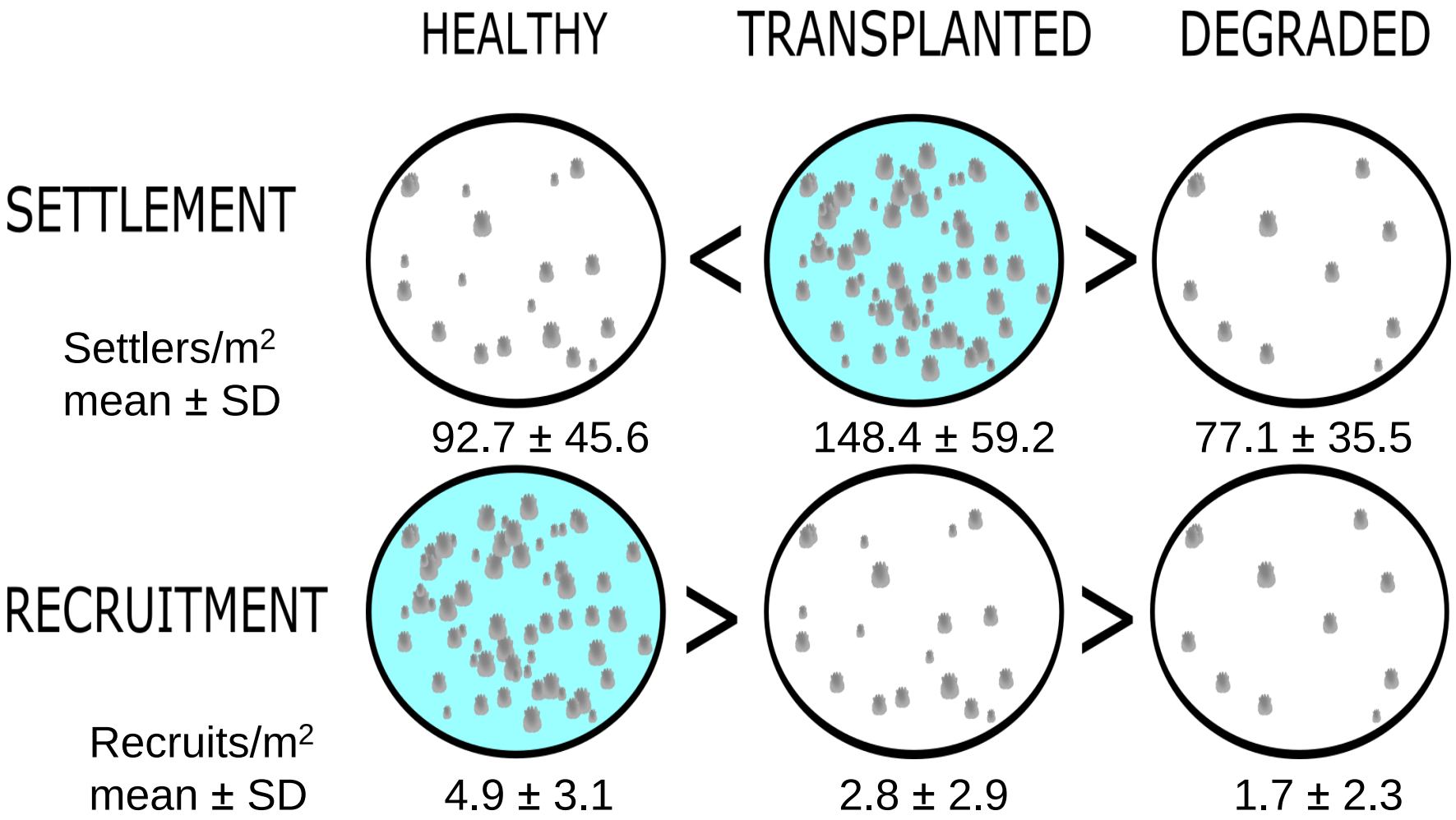
Fish size


30
25
20
15
10
5
0
Mean fish per 154m²
<10
11 - 20
21 - 30
31 - 40
41 - 50
51 - 60
81 - 90
Total length (cm)
Healthy
Transplanted
Degraded

Fish feeding guilds – April 2015

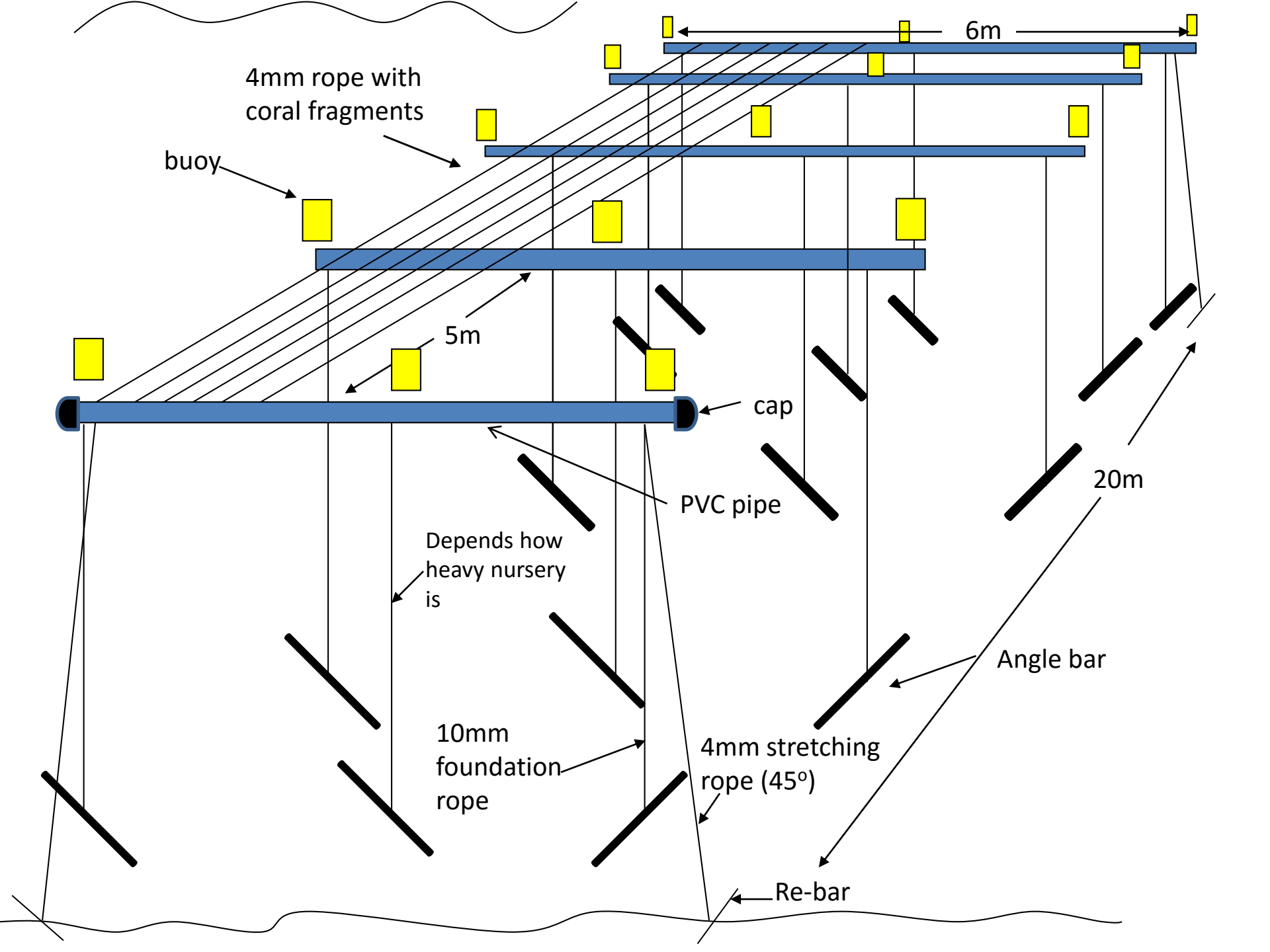


Enhancing coral settlement and recruitment



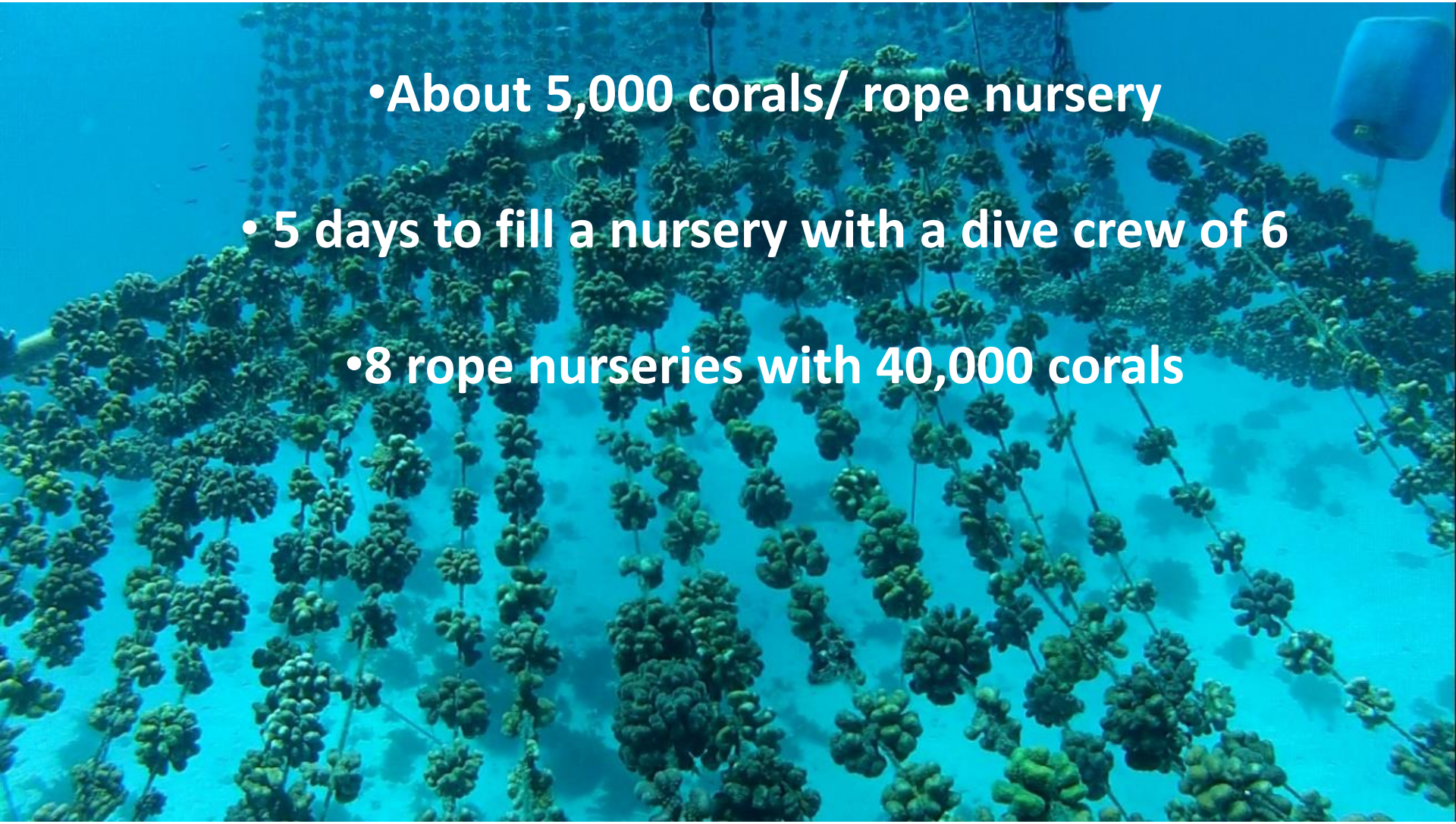
Montoya-Maya P. Smit K, Burt A, Frias-Torres S. *In press*. Coral transplantation onto damaged reefs enhances natural recovery in the Seychelles, Indian Ocean. *Restoration Ecology.*

Building foundations for a mid-water coral nursery


6m
4mm rope with
coral fragments
buoy
5m
cap
PVC pipe
20m
Depends how
heavy nursery
is
Angle bar
10mm
foundation
rope
4mm stretching
rope (45°)
Re-bar

Filling ropes with coral fragments

Rope nursery



- About 5,000 corals/ rope nursery
- 5 days to fill a nursery with a dive crew of 6
- 8 rope nurseries with 40,000 corals

Net nursery

- 480 corals/ net nursery
- 5 days to fill a net nursery
- 3 net nurseries and about 1,440 corals

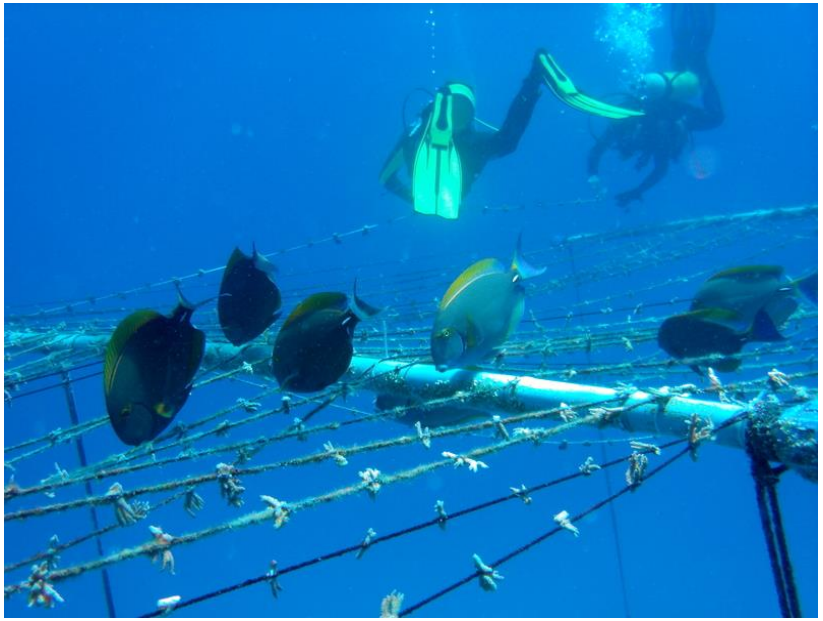
Growth of coral fragment in rope nursery

5 March 2012

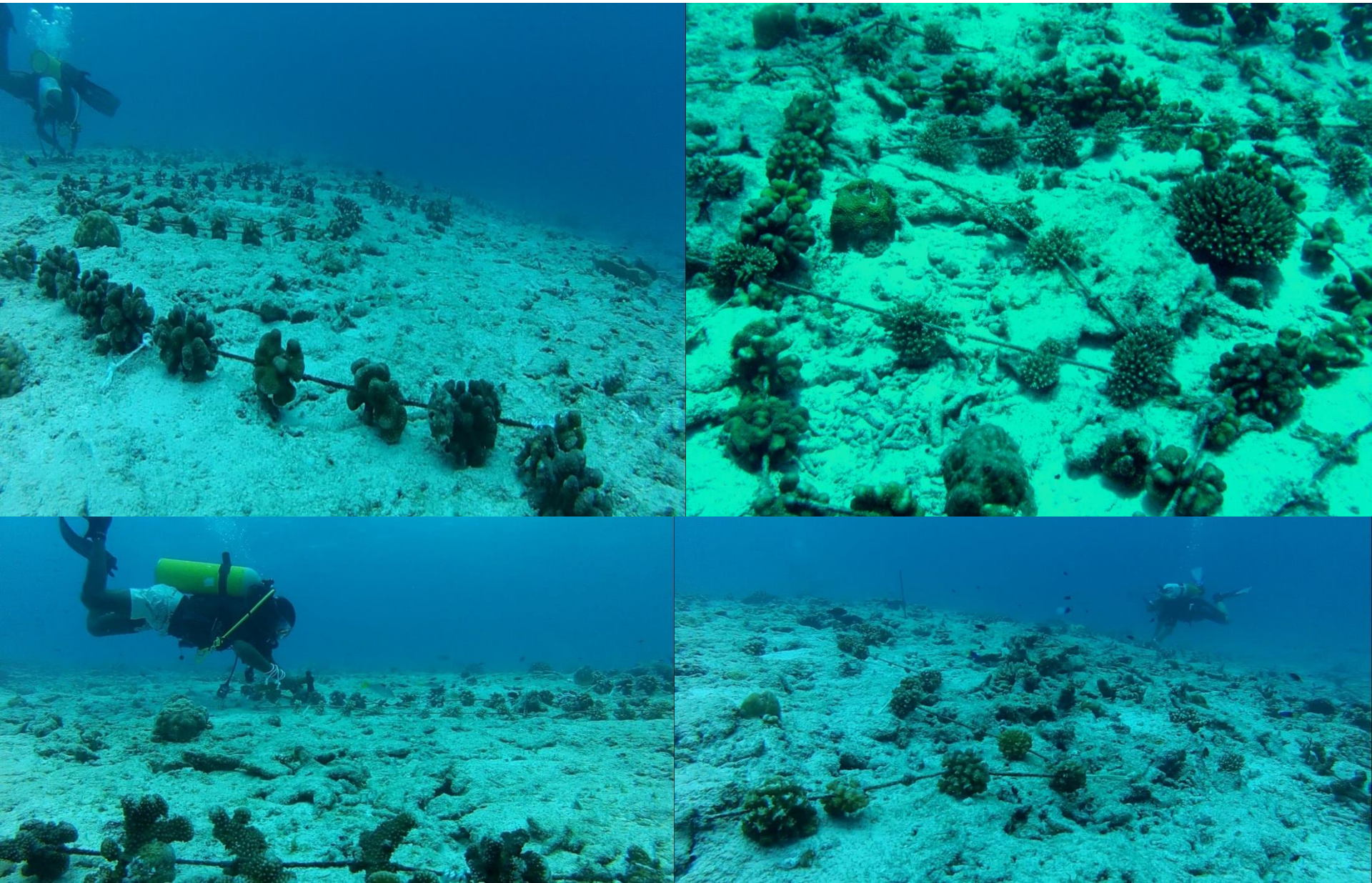
26 April 2012

6 June 2012

Cleaning nurseries



Anchoring coral nursery ropes with nails



Cementing individual colonies

Coral reef restoration human effort

Permanent Staff:

1 project coordinator

1 technical officer

1 dive leader

1 boatman

Rotating Staff:

2 – 6 scientific divers

Expertise

Total Staff: 6 – 10 people/year

Coral reef restoration infrastructure

- Field laboratory with office space
- Dive shed: air compressor,

  12 tanks, gear cleaning and basic maintenance tools
- Full SCUBA gear for each scientific diver (volunteer divers provide their own)
- 15 feet boat + 50 Hp engine