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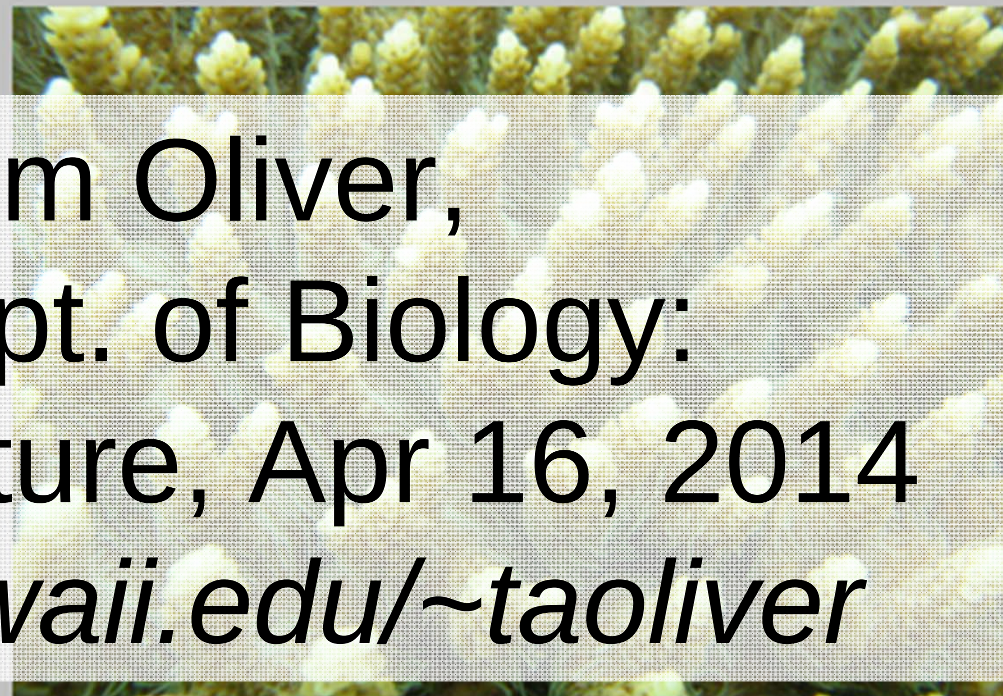
Oliver Lab — University of Hawai‘i, Mānoa

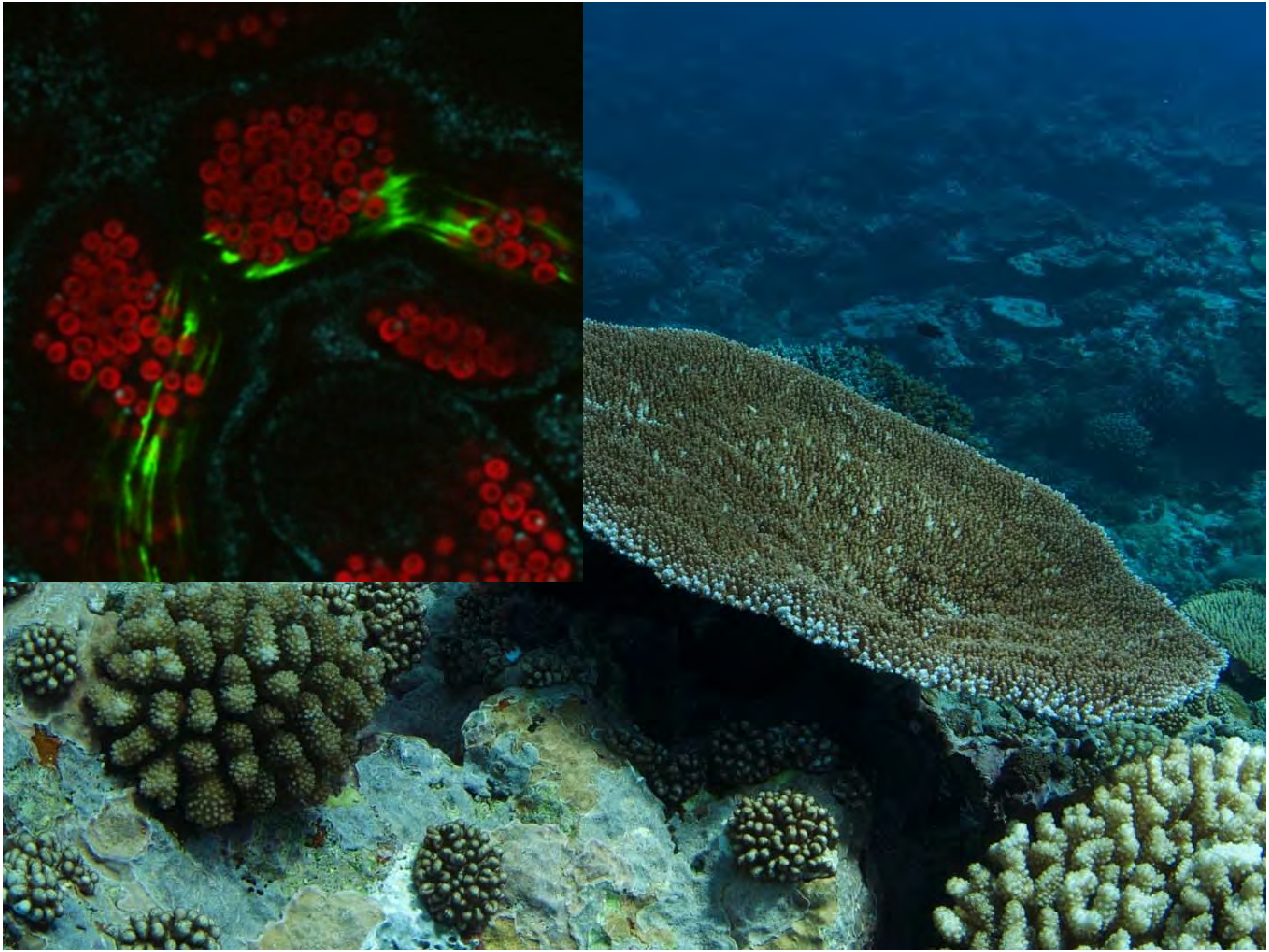


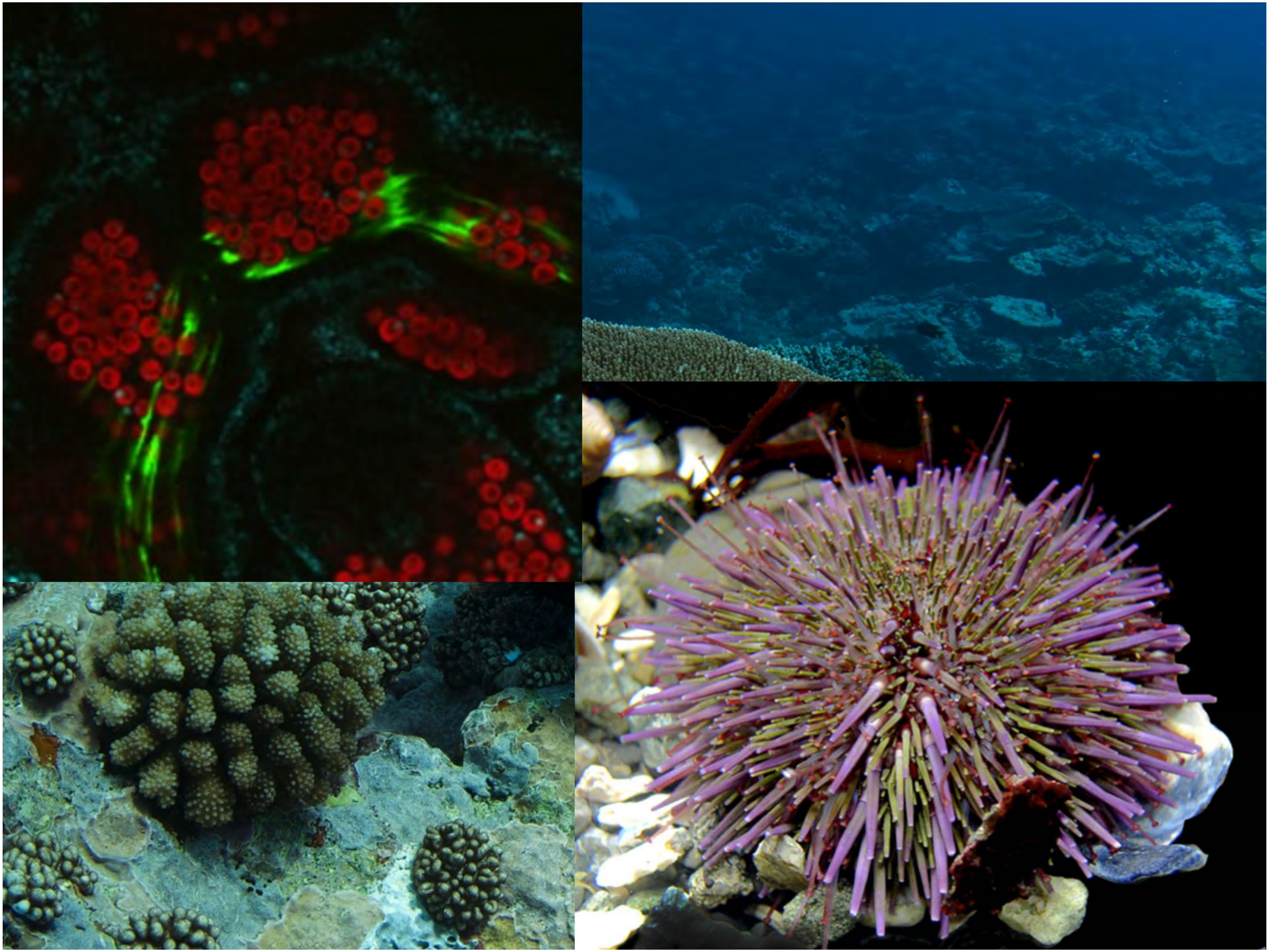
Tom Oliver,
UH Dept. of Biology:
NREM Lecture, Apr 16, 2014
www2.hawaii.edu/~taoliver

Oliver Lab - UH Biology

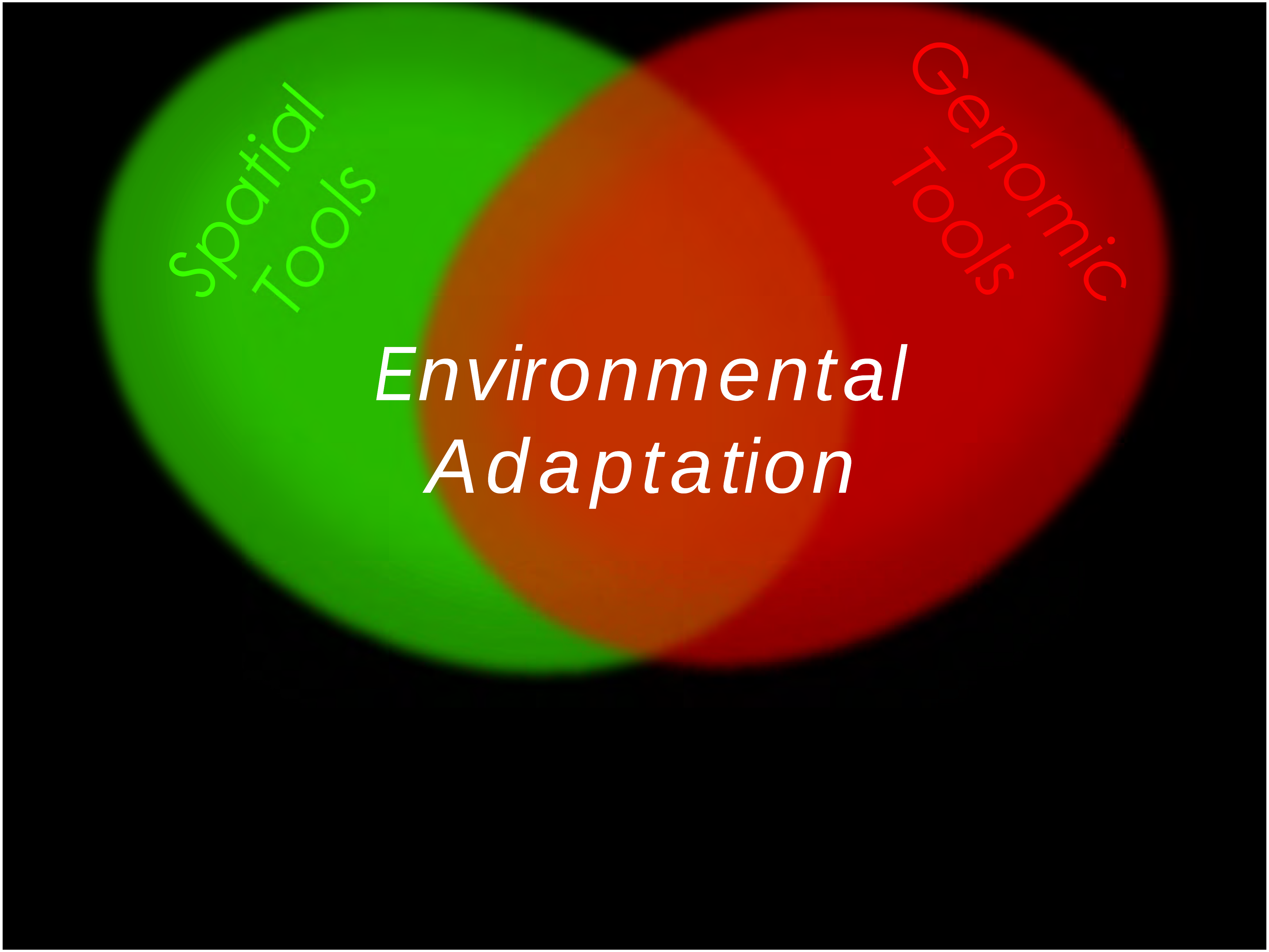
- Evolutionary Ecology & Genomics of Reef Corals
- Organismal Response to Environmental Change
- Effective Marine Management Strategies

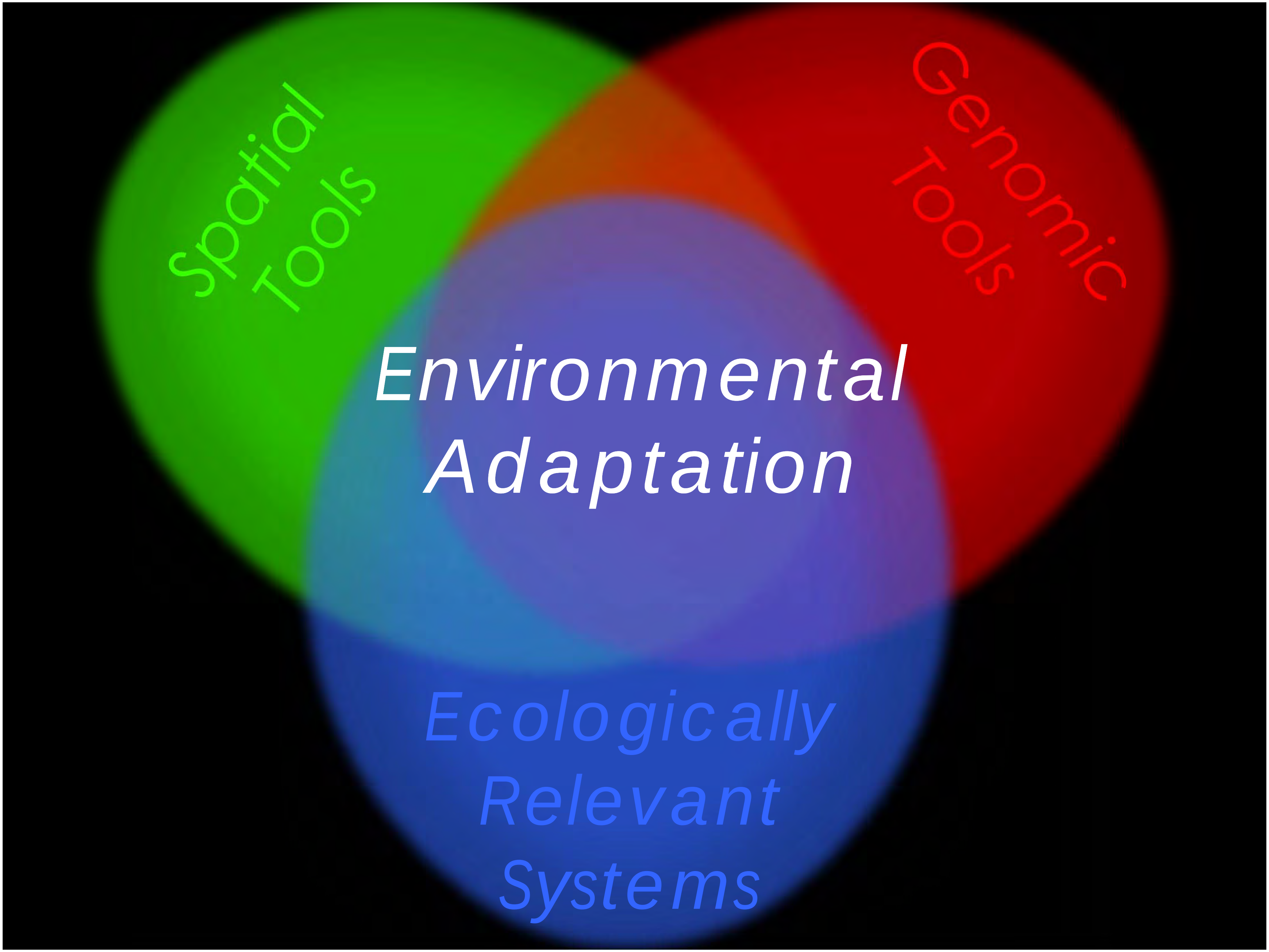
My research applies genomic and bioinformatic tools to study the spatial and genomic patterns of natural selection. I study a range of marine organisms, from microbes, to urchins, to corals.

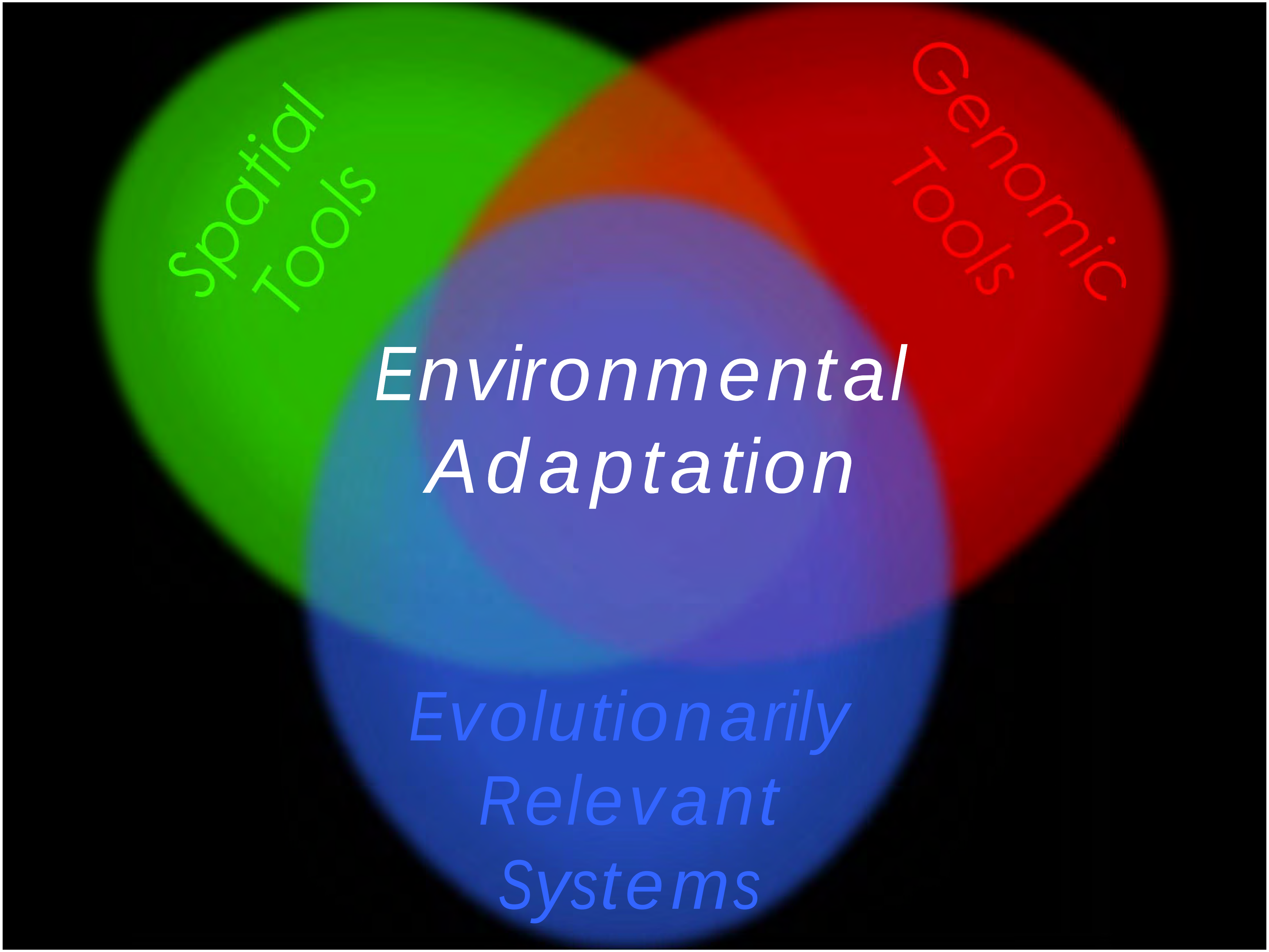


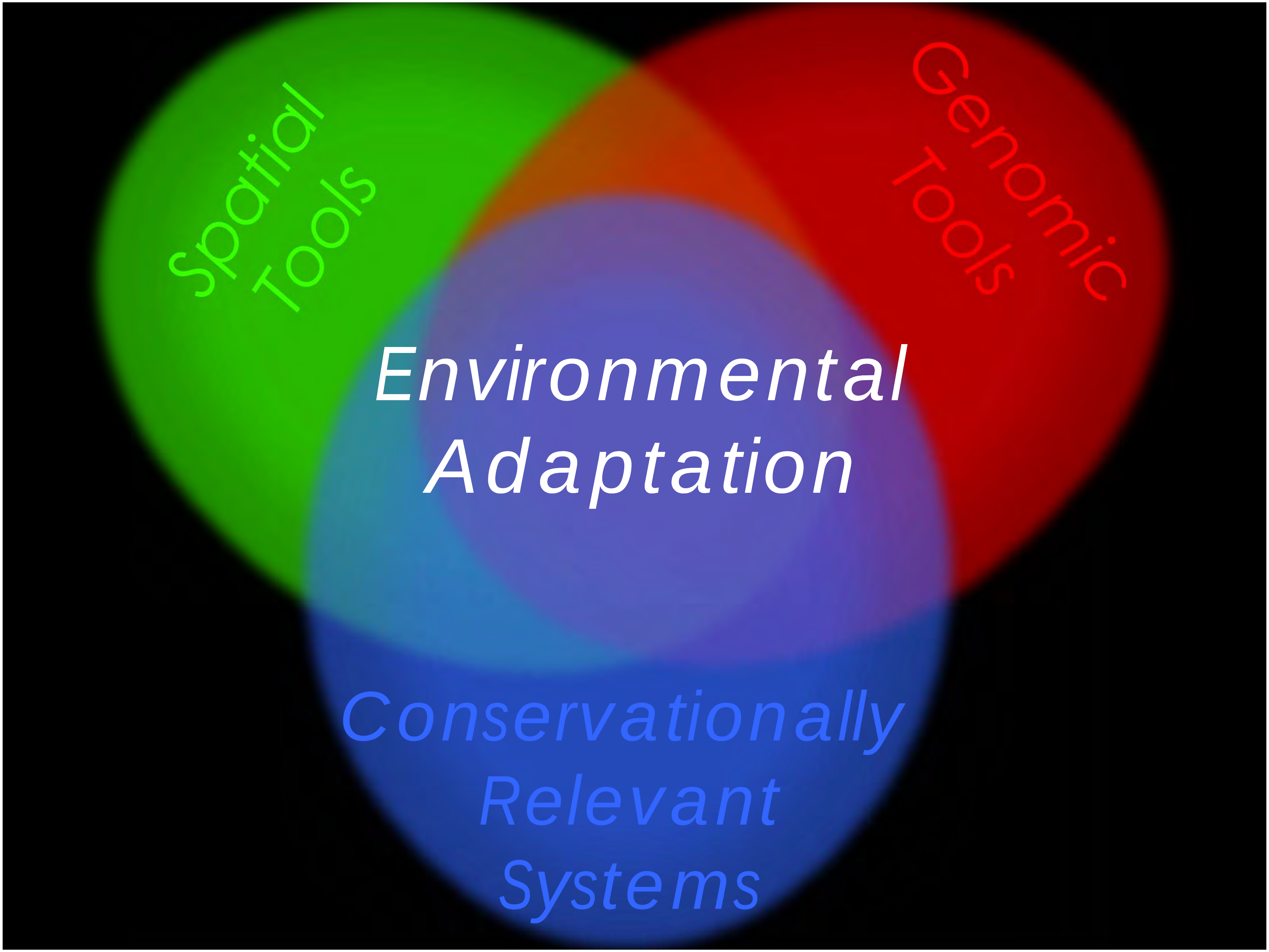


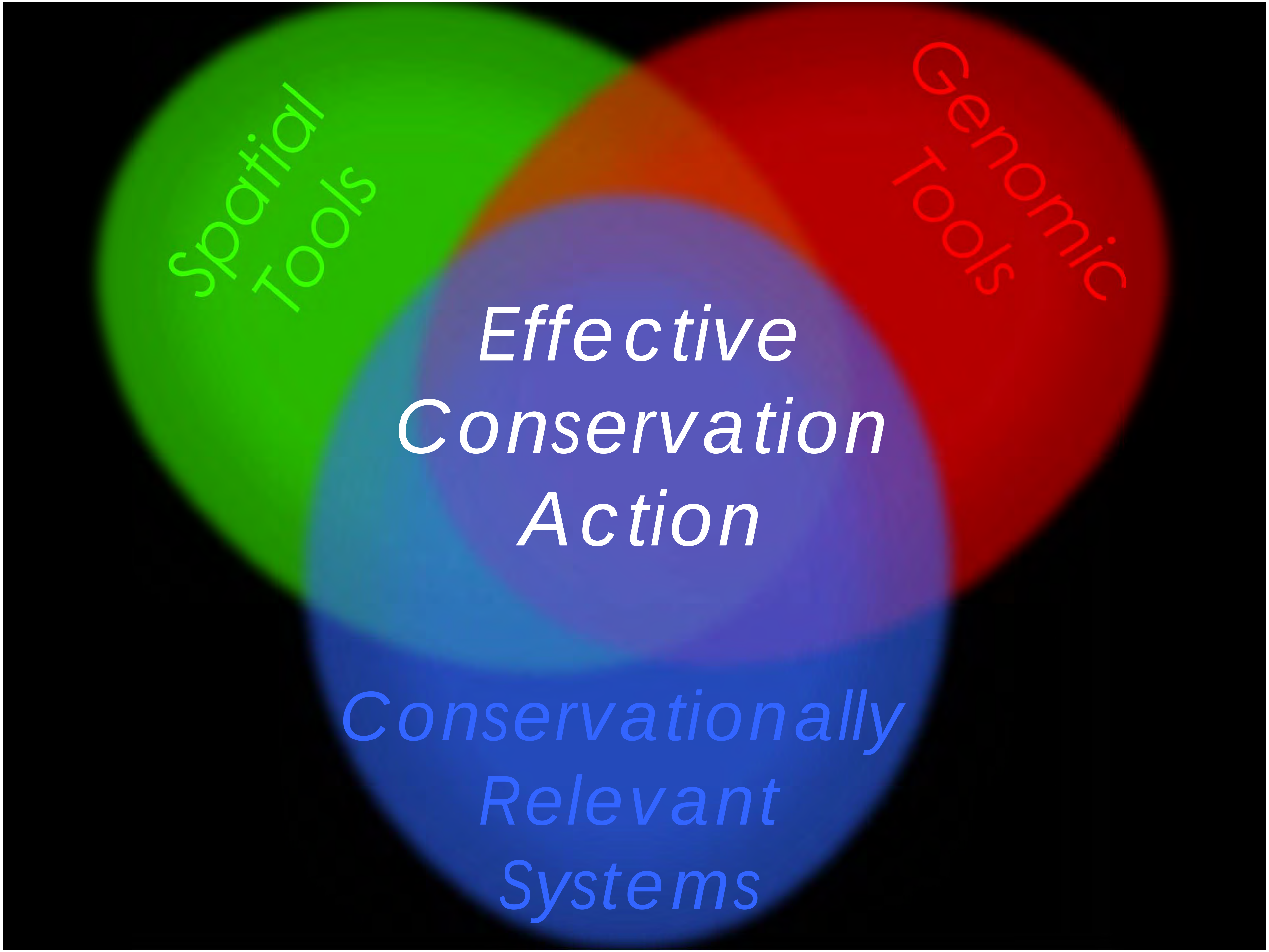
Environmental Adaptation


Spatial Tools
Genomic Tools
Environmental Adaptation


Spatial Tools
Genomic Tools
Environmental Adaptation
Ecologically Relevant Systems


Spatial Tools
Genomic Tools
Environmental Adaptation
Evolutionarily Relevant Systems


Spatial Tools
Genomic Tools
Environmental Adaptation
Conservationally Relevant Systems


Spatial Tools
Genomic Tools
Effective Conservation Action
Conservationally Relevant Systems

1. What *stressors* do coral reefs face?

2. What *actions* can managers take to reduce/remove these stressors?

3. How do we make these actions *effective*?

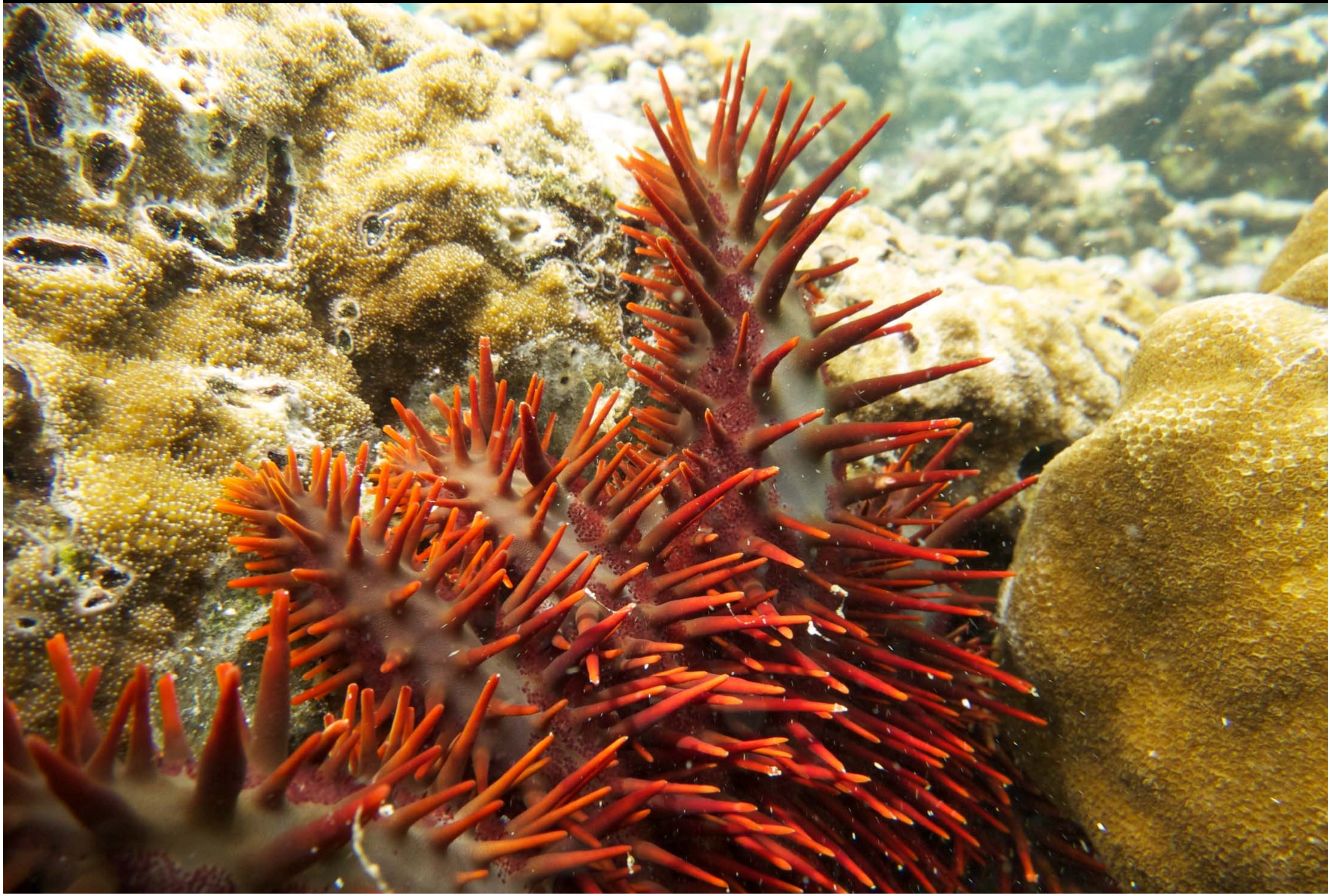
4. How can *research* help (if it can)?

Poor Water Quality

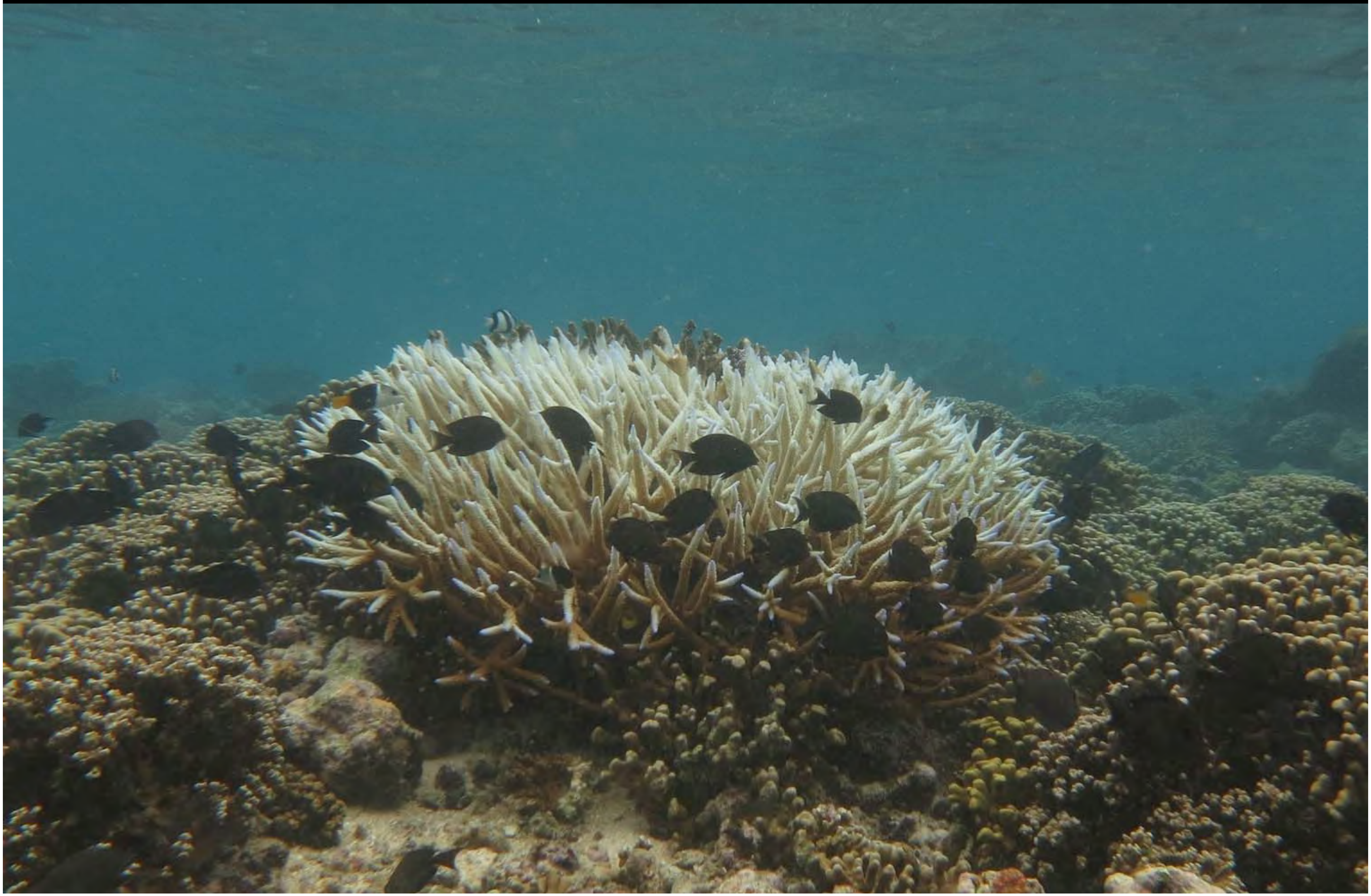
Overfishing

Algal Overgrowth

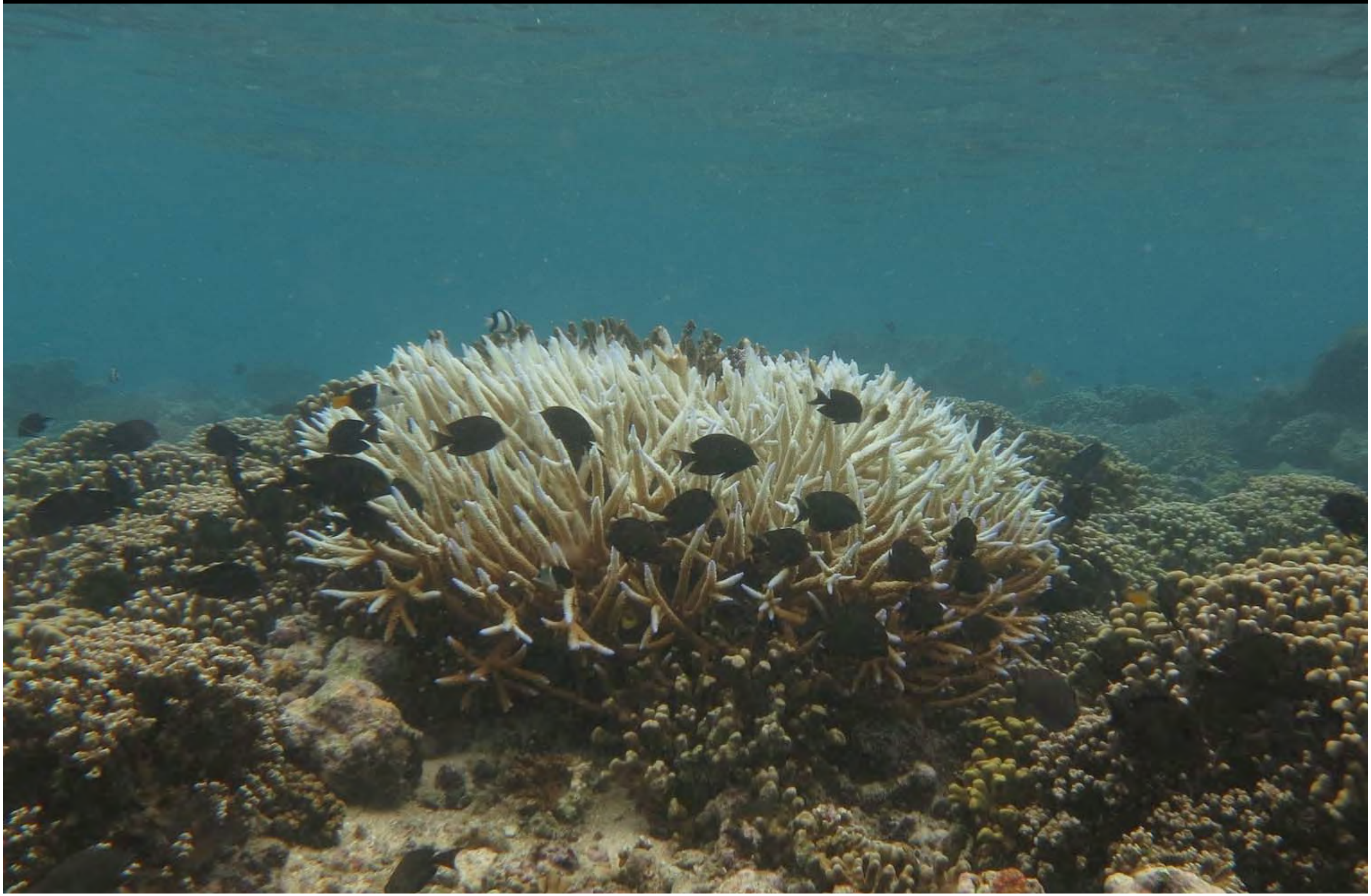
Crown of Thorns



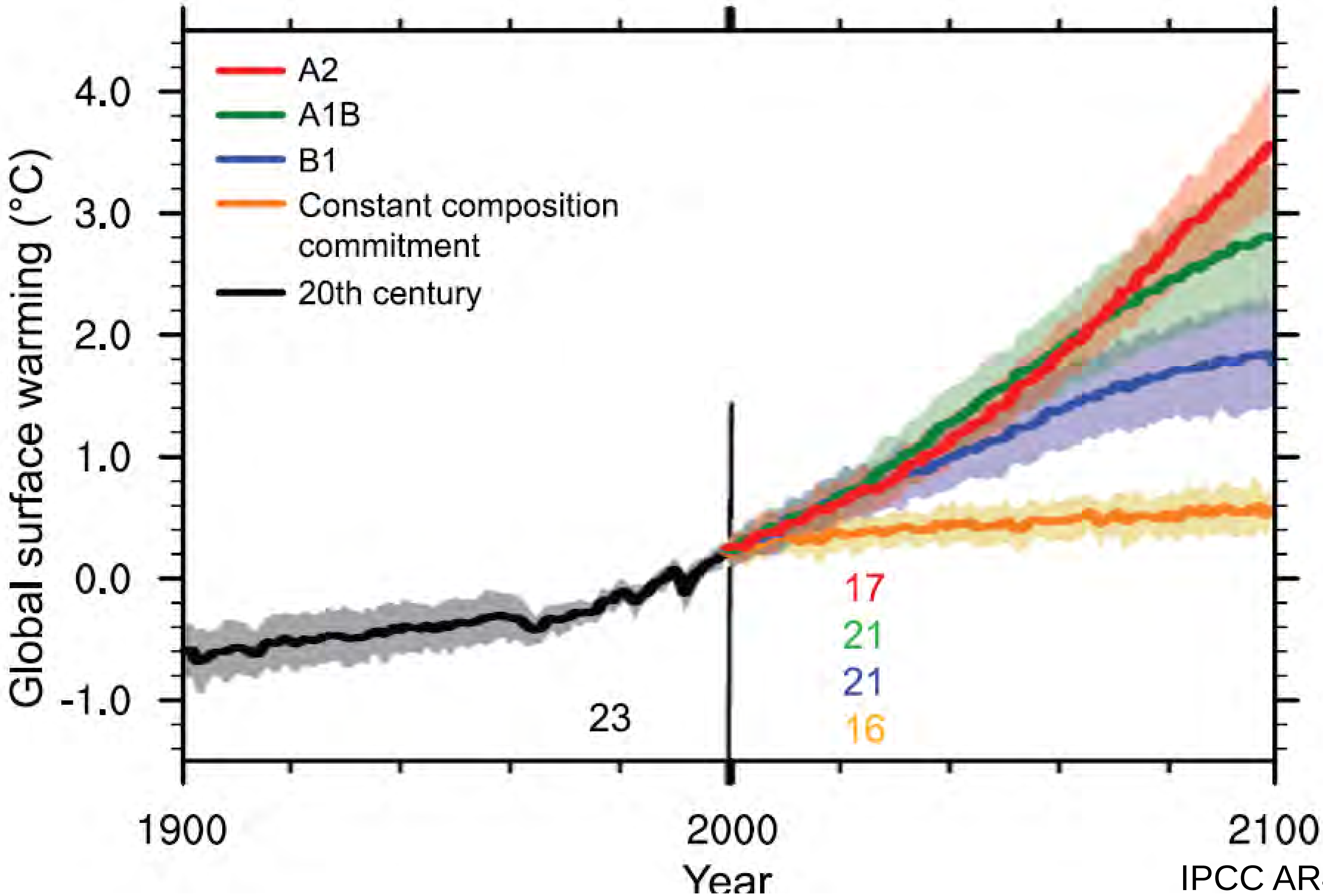
Rising Temperatures - Coral Bleaching



Rising Temperatures - Coral Bleaching



The World is Warming



IPCC AR4

Local
Stressors

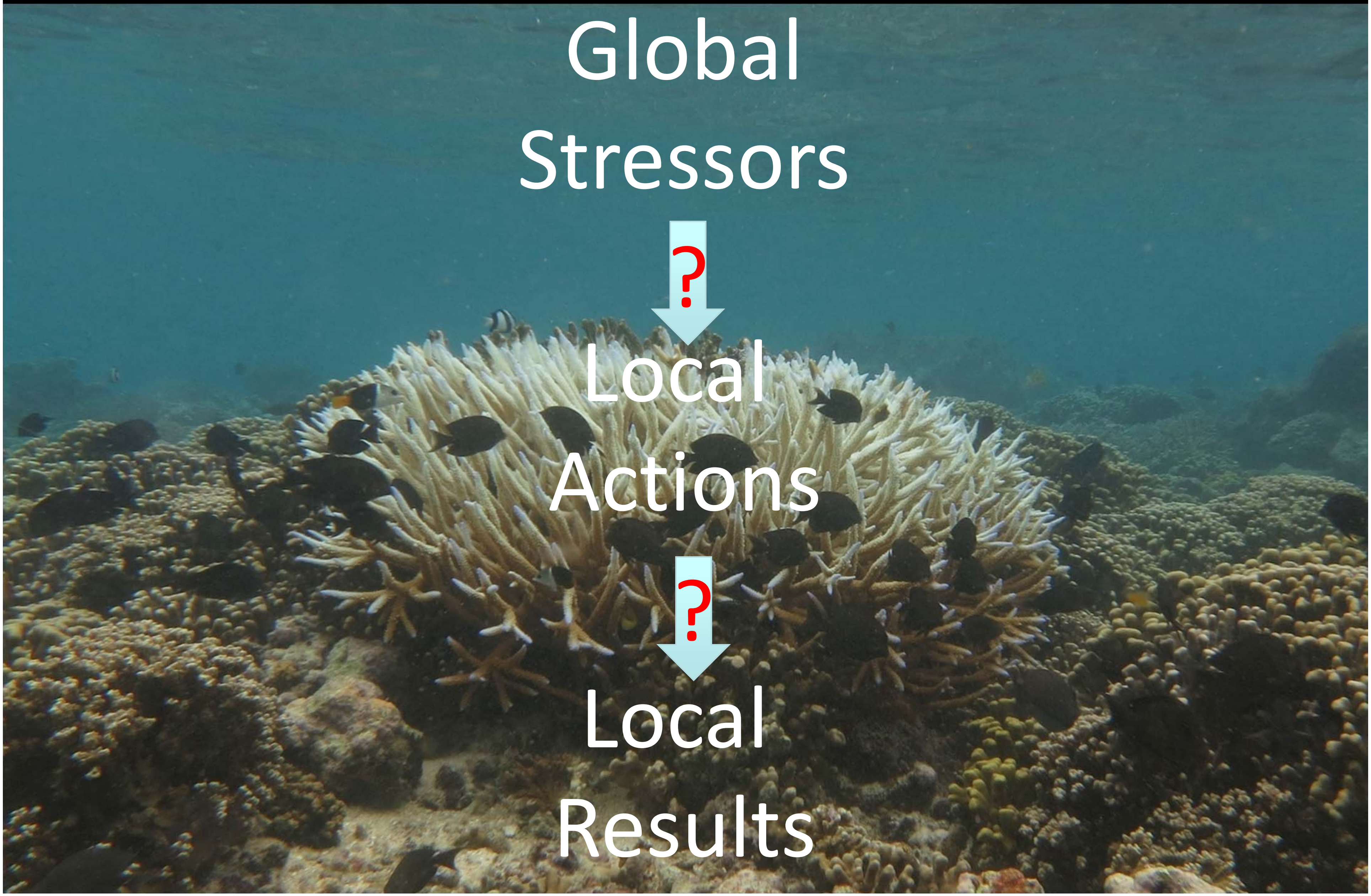
↓

Local
Actions

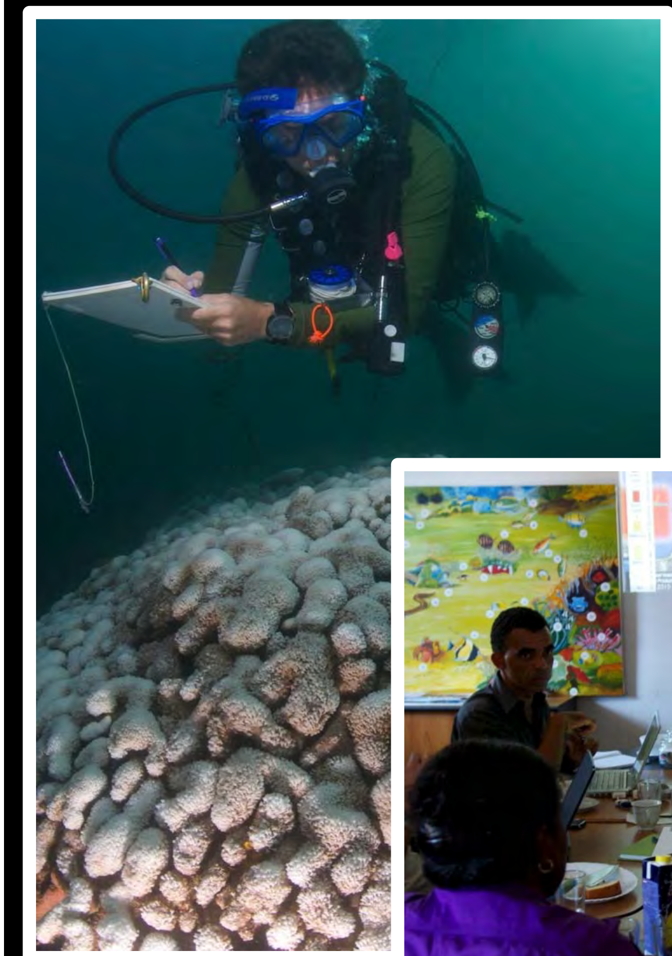
↓

Local
Results

Rising Temperatures - Coral Bleaching



Reef 'Resilience' Prioritization For Marine Spatial Planning



Resilience Assessment

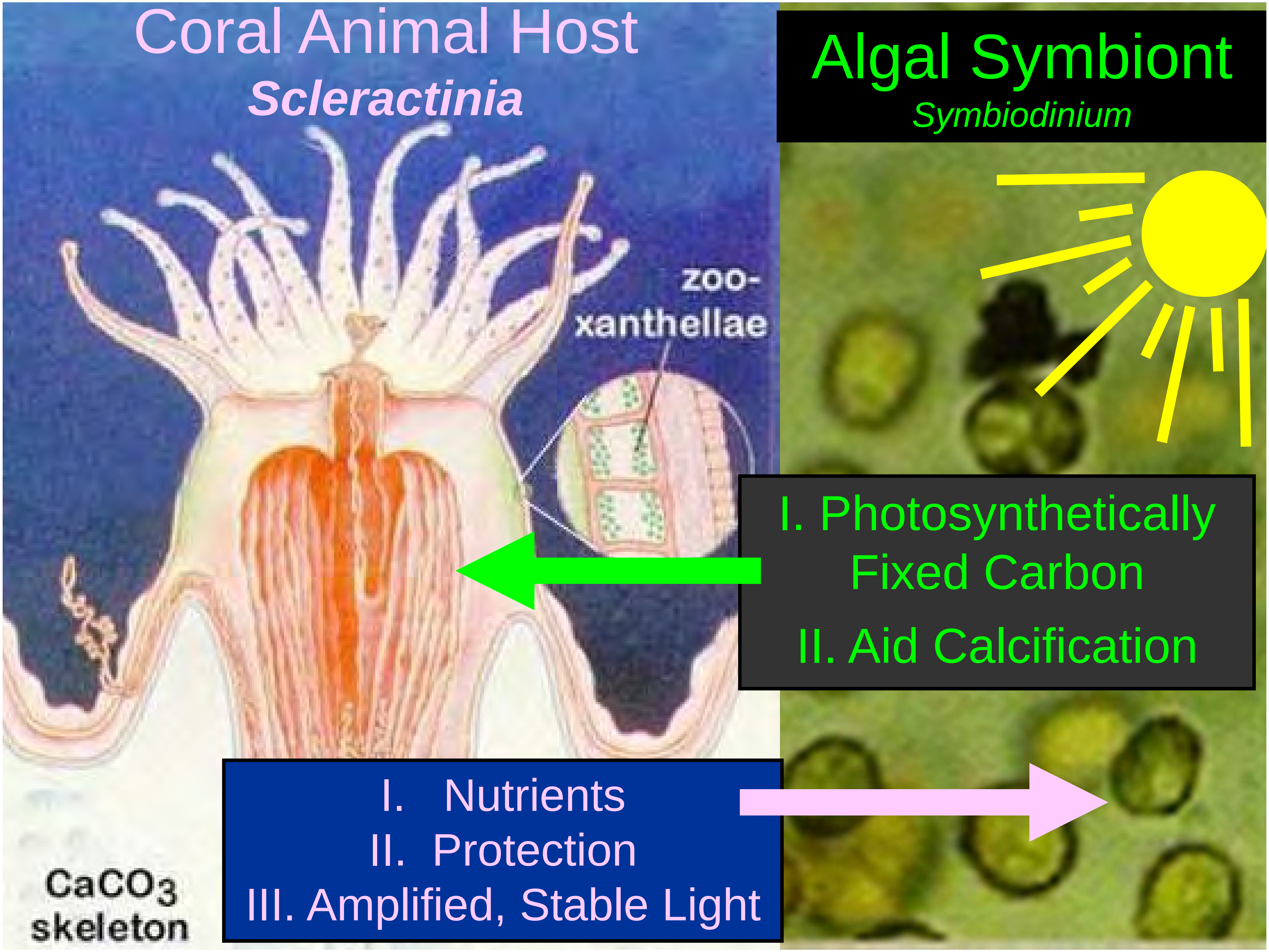
- Percent Cover Corals
- Fish Biomass
- Coral Diversity
- Fish Diversity
- Fish Size Structure
- Coral Size Structure
- Unique Current Systems
- Connnectitiy

Resilience =
Resistance & Recovery

Resistance Assessment

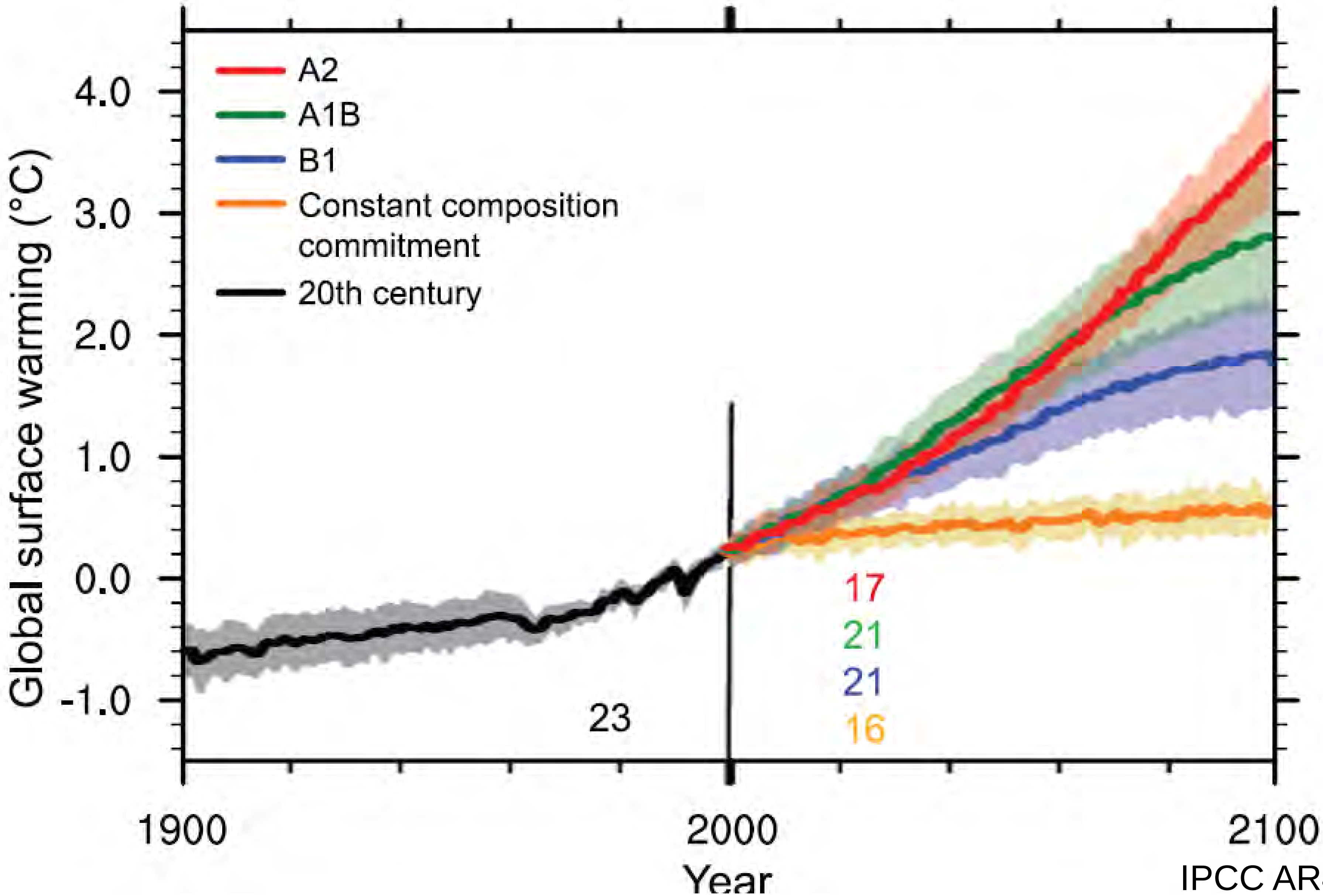
Local Responses to Global Threats: American Samoa

Ofu Island, American Samoa


Coral Animal Host
Scleractinia
Algal Symbiont
Symbiodinium
zoo-
xanthellae
I. Photosynthetically
Fixed Carbon
II. Aid Calcification
I. Nutrients
II. Protection
III. Amplified, Stable Light
$CaCO_3$
skeleton

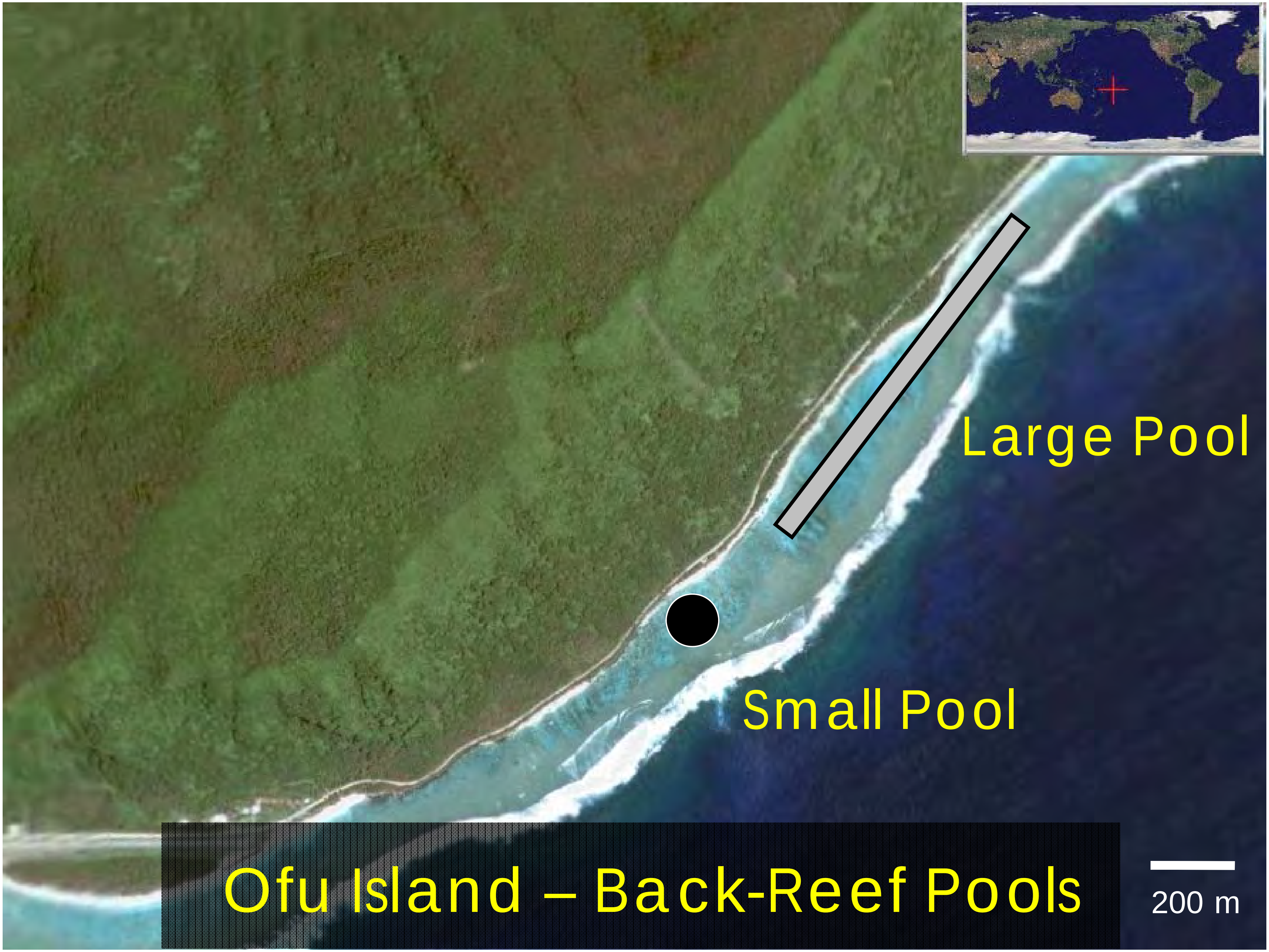
Coral Bleaching

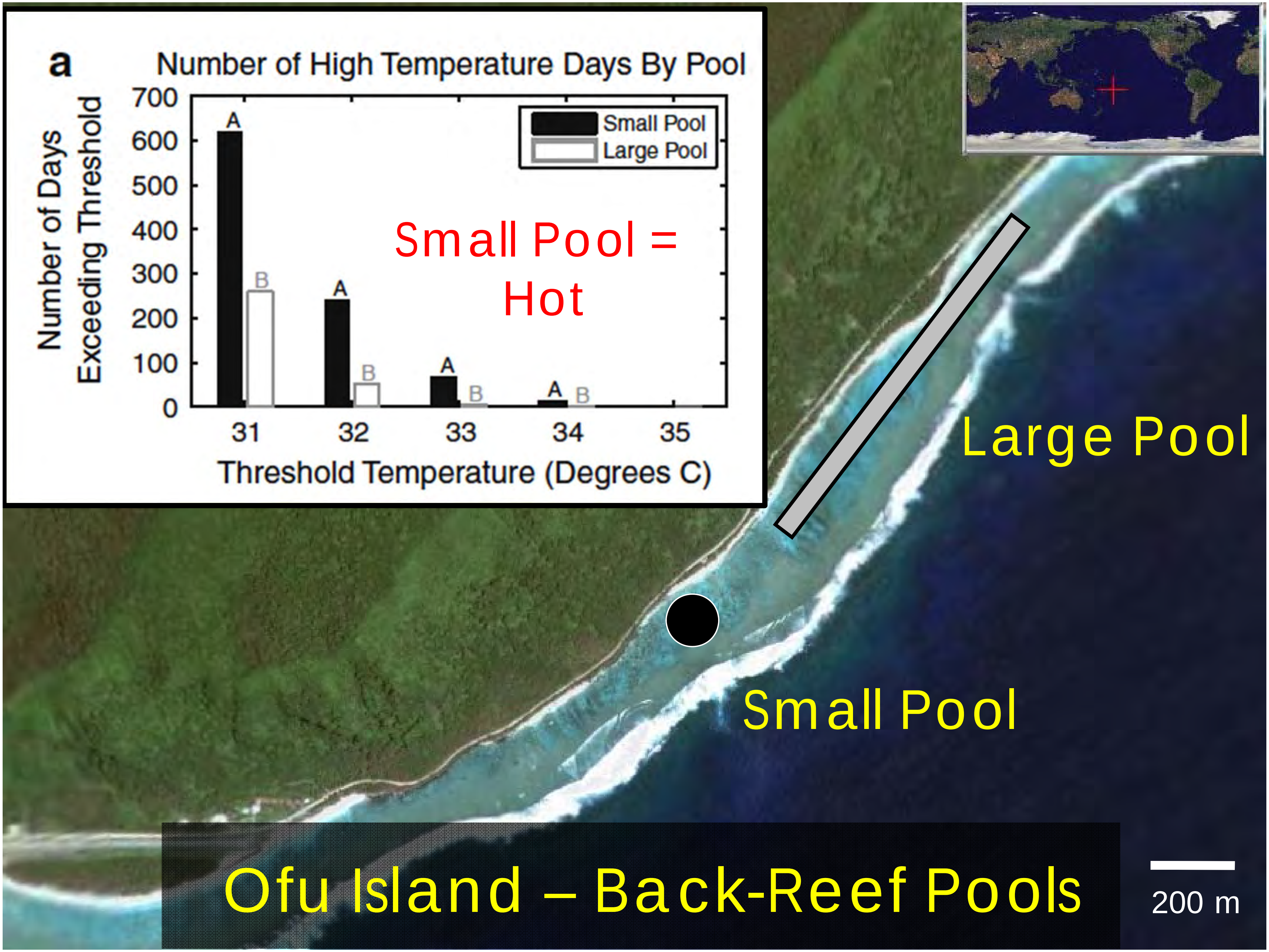
The World is Warming



IPCC AR4

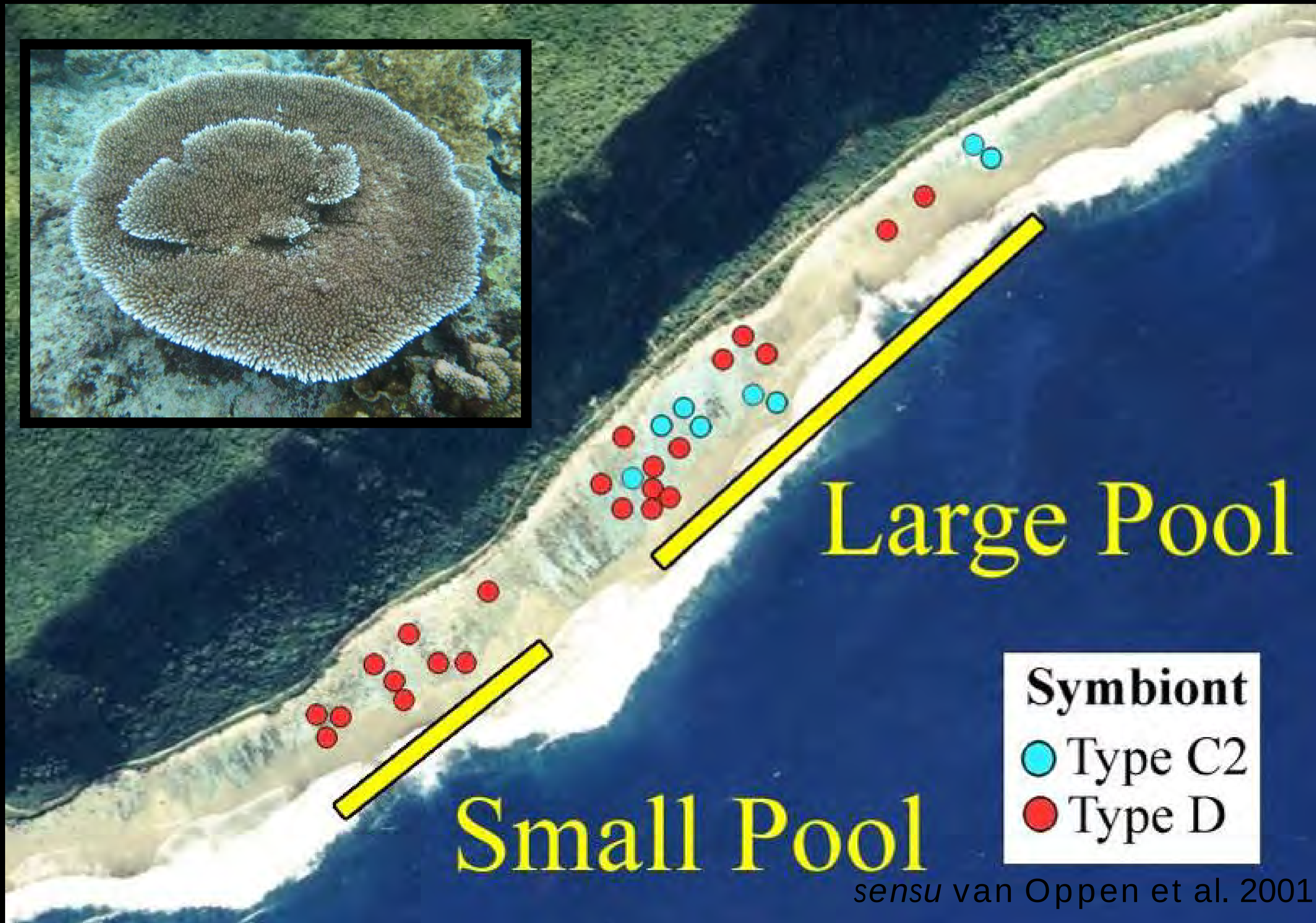

Ofu Island – Back-Reef Pools
200 m


Large Pool
Small Pool
Ofu Island – Back-Reef Pools
200 m



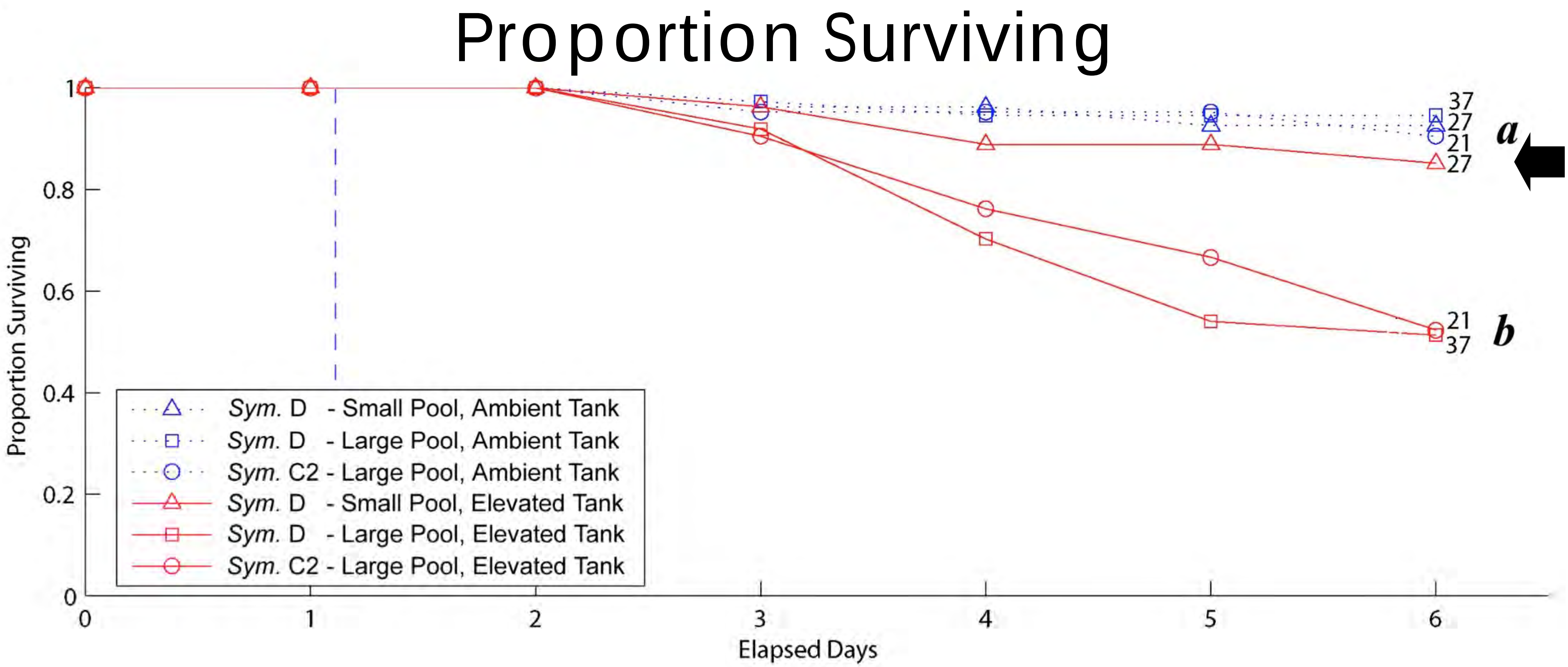
a
Number of High Temperature Days By Pool
Number of Days Exceeding Threshold
700
600
500
400
300
200
100
0
A
B
A
B
A
B
A
B
Small Pool
Large Pool
Small Pool = Hot
31
32
33
34
35
Threshold Temperature (Degrees C)
Large Pool
Small Pool
Ofu Island – Back-Reef Pools
200 m

Acropora hyacinthus



(1) Type D, Small Pool (2) Type D, Large Pool (3) Type C2, Large Pool

Phenotypic Difference in Coral Thermal Tolerance

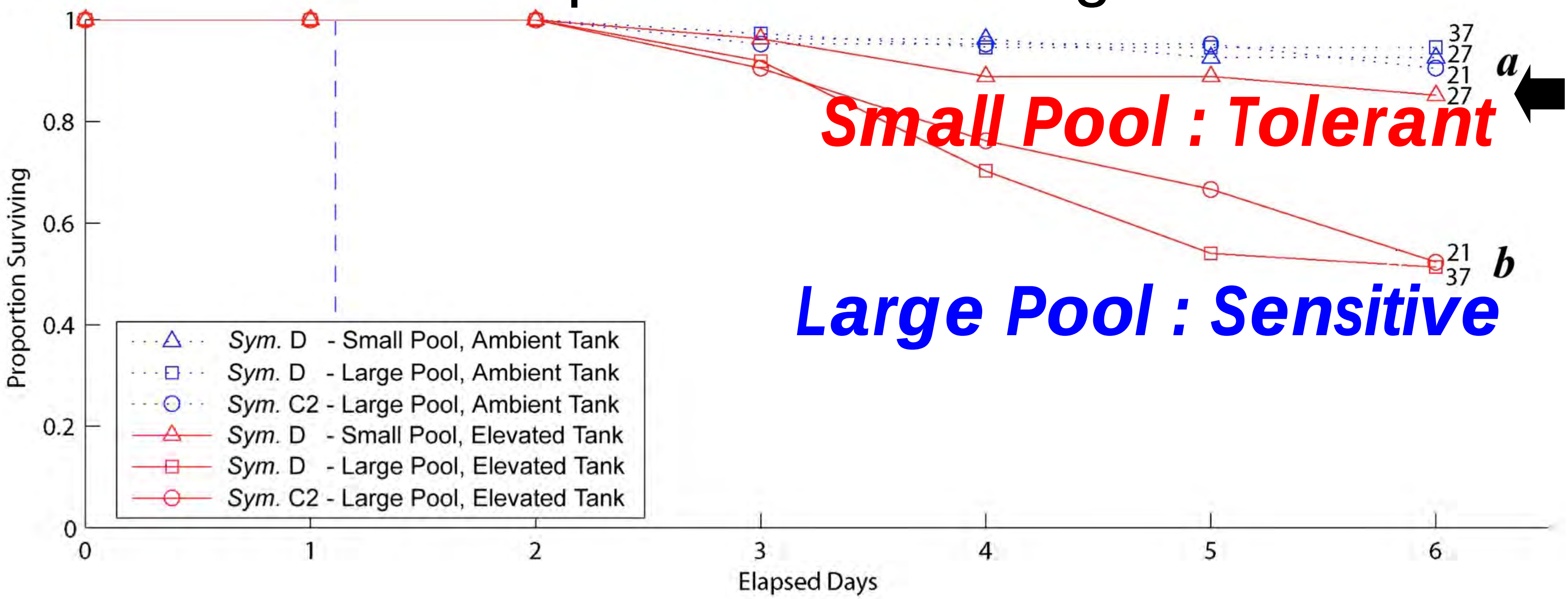


Corals from Large Pool suffered high mortalities whether they hosted *Sym*. C2 or D

Cox Prop. Hazard Regression a vs. b pval=0.013

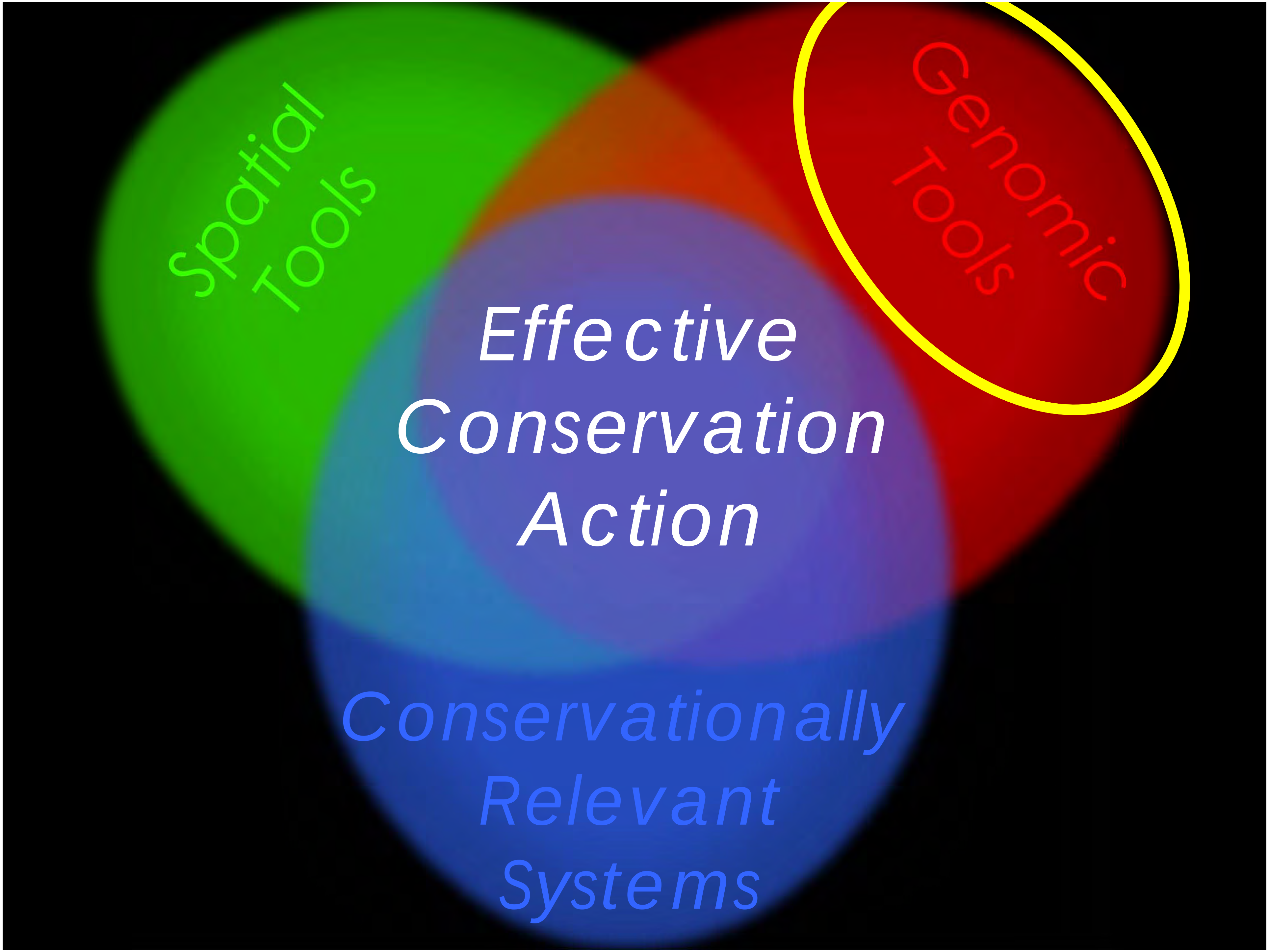
Phenotypic Difference in Coral Thermal Tolerance

Proportion Surviving

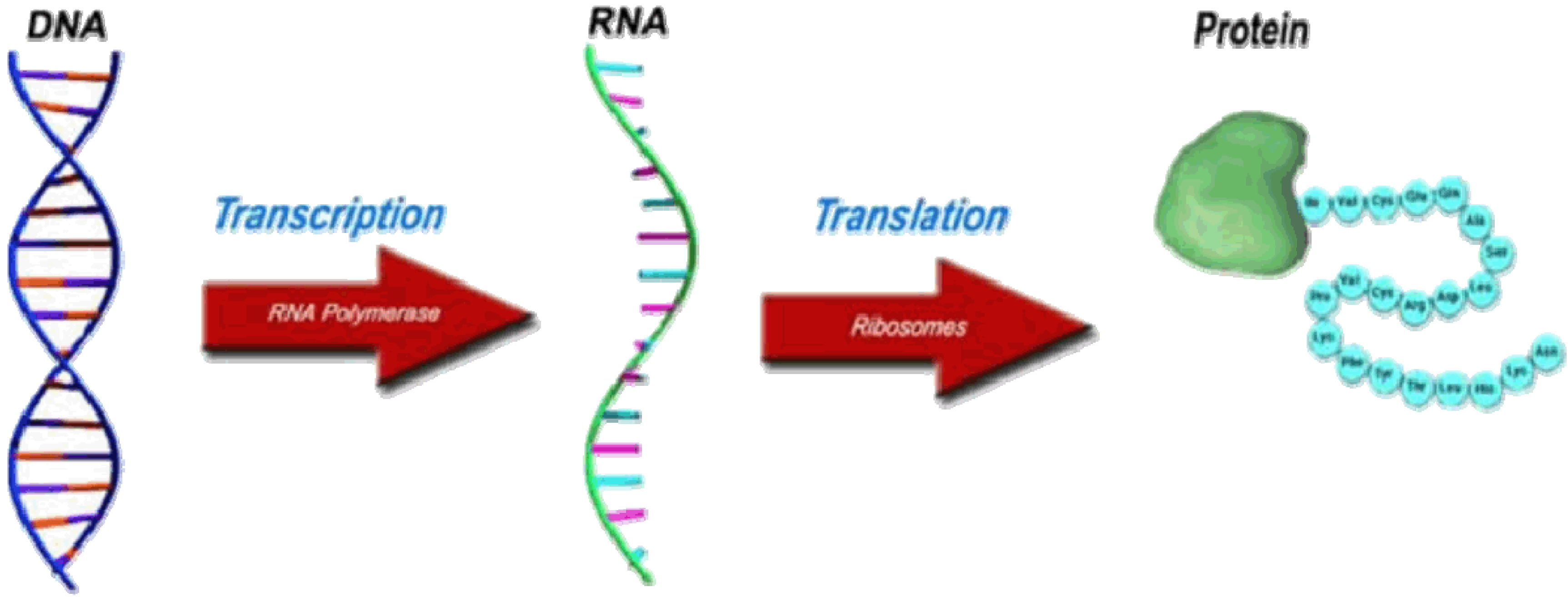


Corals from Large Pool suffered high mortalities whether they hosted *Sym*. C2 or D

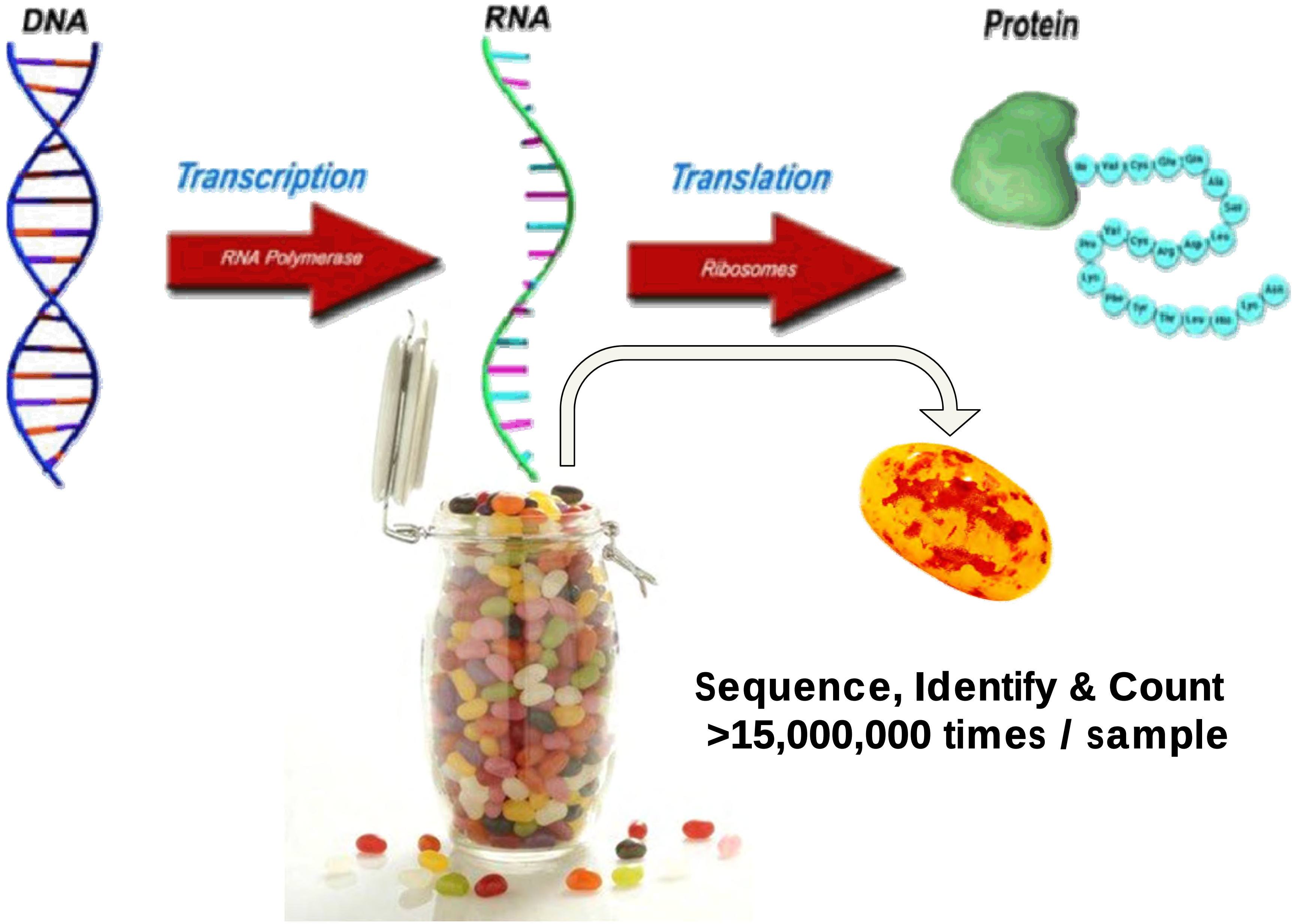
Cox Prop. Hazard Regression a vs. b pval=0.013


Spatial Tools
Genomic Tools
Effective Conservation Action
Conservationally Relevant Systems

mRNA-Seq


DNA
Transcription
RNA Polymerase
RNA
Translation
Ribosomes
Protein

mRNA-Seq



Sequence, Identify & Count
>15,000,000 times / sample

mRNA-Seq

Large Pool :
Sensitive

Small Pool :
Tolerant

Vol. 378: 93–103, 2009
doi: 10.3354/meps07871

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Published March 12

Distributions of stress-resistant coral symbionts match environmental patterns at local but not regional scales

Thomas A. Oliver*, Stephen R. Palumbi

Coral Reefs (2011) 30:241–250
DOI 10.1007/s00338-010-0696-0

REPORT

Many corals host thermally resistant symbionts in high-temperature habitat

T. A. Oliver · S. R. Palumbi

Coral Reefs (2011) 30:429–440
DOI 10.1007/s00338-011-0721-y

REPORT

Do fluctuating temperature environments elevate coral thermal tolerance?

T. A. Oliver · S. R. Palumbi

PNAS

Genomic basis for coral resilience to climate change

Daniel J. Barshis[1,2], Jason T. Ladner, Thomas A. Oliver, François O. Seneca, Nikki Traylor-Knowles, and Stephen R. Palumbi

Department of Biology, Hopkins Marine Station, Stanford University, Pacific Grove, CA 93950

Edited by David M. Hillis, The University of Texas at Austin, Austin, TX, and approved November 30, 2012 (received for review June 15, 2012)

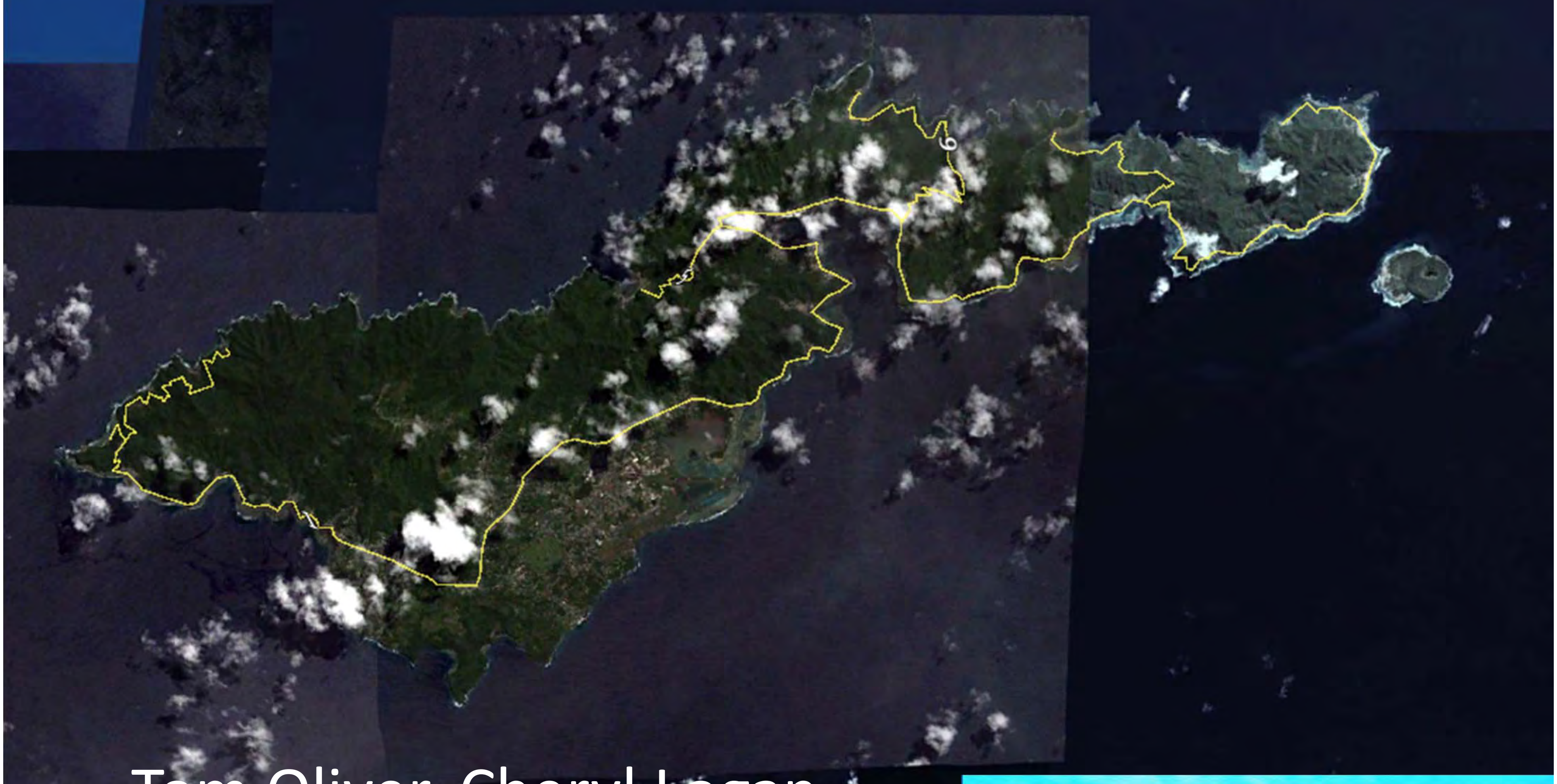
Recent advances in DNA-sequencing technologies now allow for in-depth characterization of the genomic stress responses of many organisms beyond model taxa. They are especially appropriate for organisms such as reef-building corals, for which dramatic declines in abundance are expected to worsen as anthropogenic climate

bleaching-induced mortality (19–22) has called into question whether corals have the capacity to acclimatize or adapt to global climate change (19, 20). However, during mass coral bleaching events, survival of scattered coral colonies suggests that some groups of corals may possess inherent physiological tolerance to

Ofu Island, American Samoa

American Samoa…

Building The Atlas of Coral Thermal Tolerance for American Samoa



Tom Oliver, Cheryl Logan,
Ruth Gates, Dan Barshis

NOAA CORAL REEF CONSERVATION PROGRAM

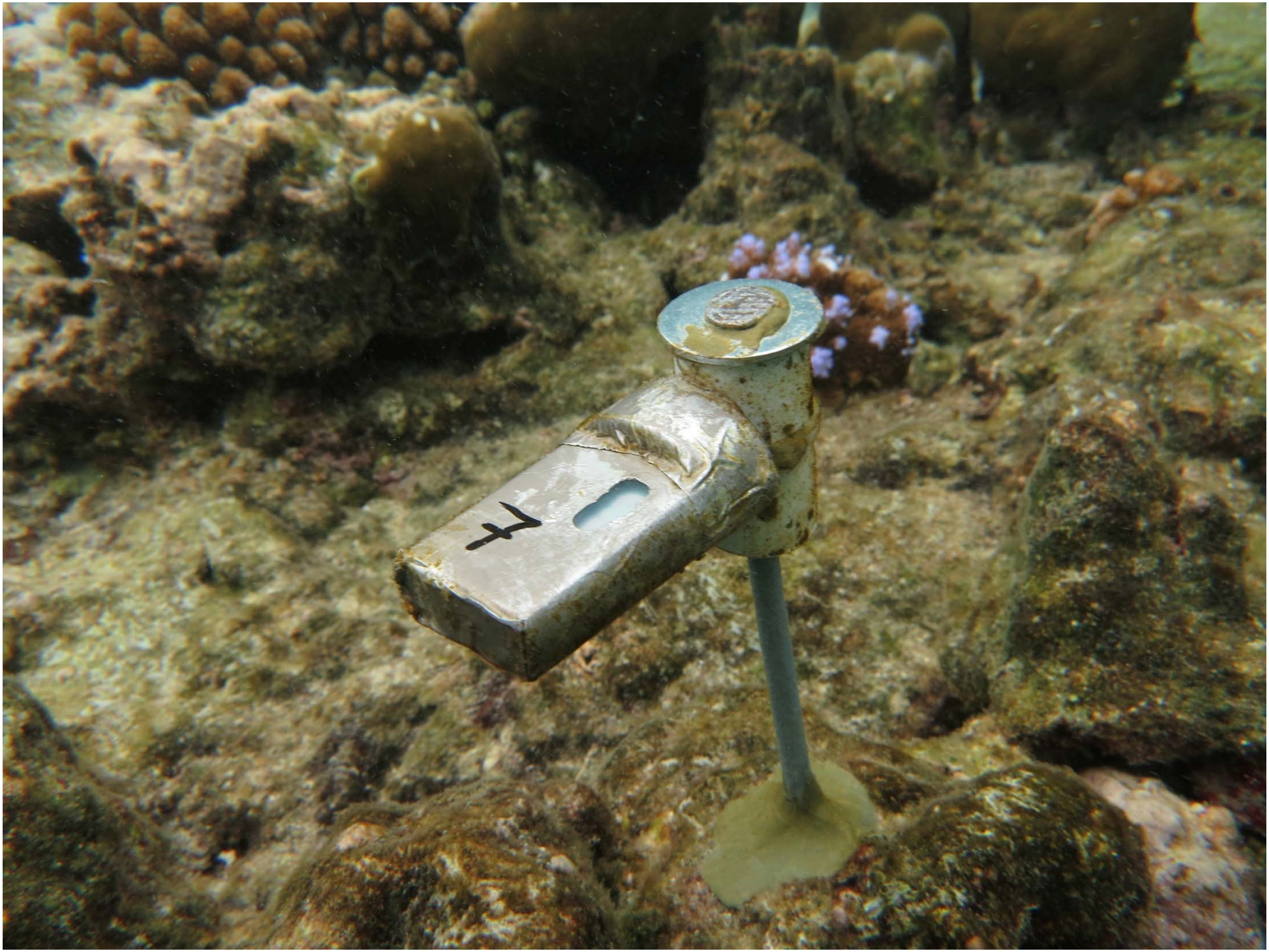
Mapping Coral Thermal Tolerance

Mapping Coral Thermal Tolerance

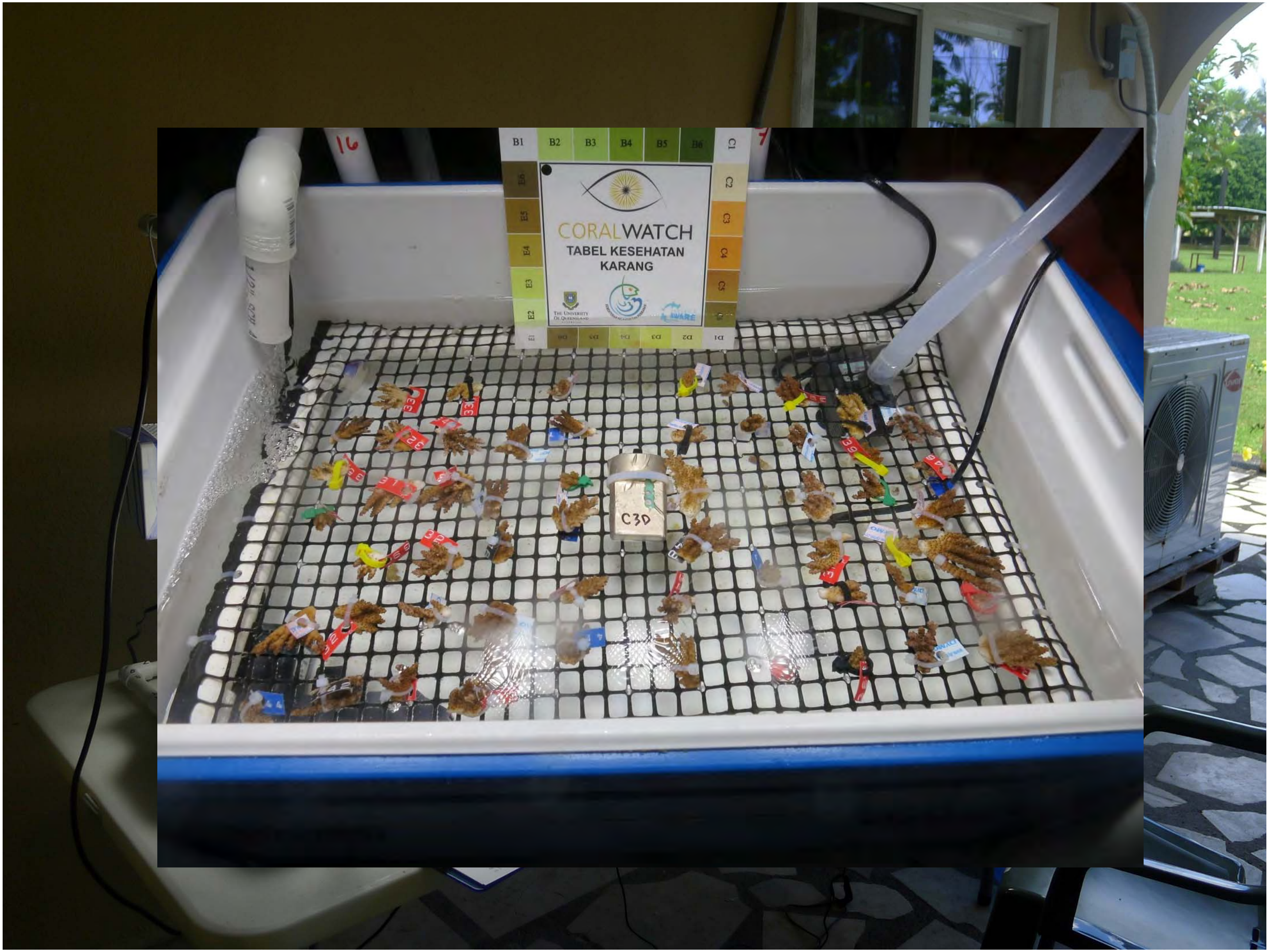
- Identify resistant/sensitive species and locations.
- Evaluate effects of *water quality* and *fisheries management* efforts on thermal thresholds.
- Build broad foundation to study genetics and evolution of coral thermal tolerance.

Select Sites: Water Quality; Thermal Regime; Management;

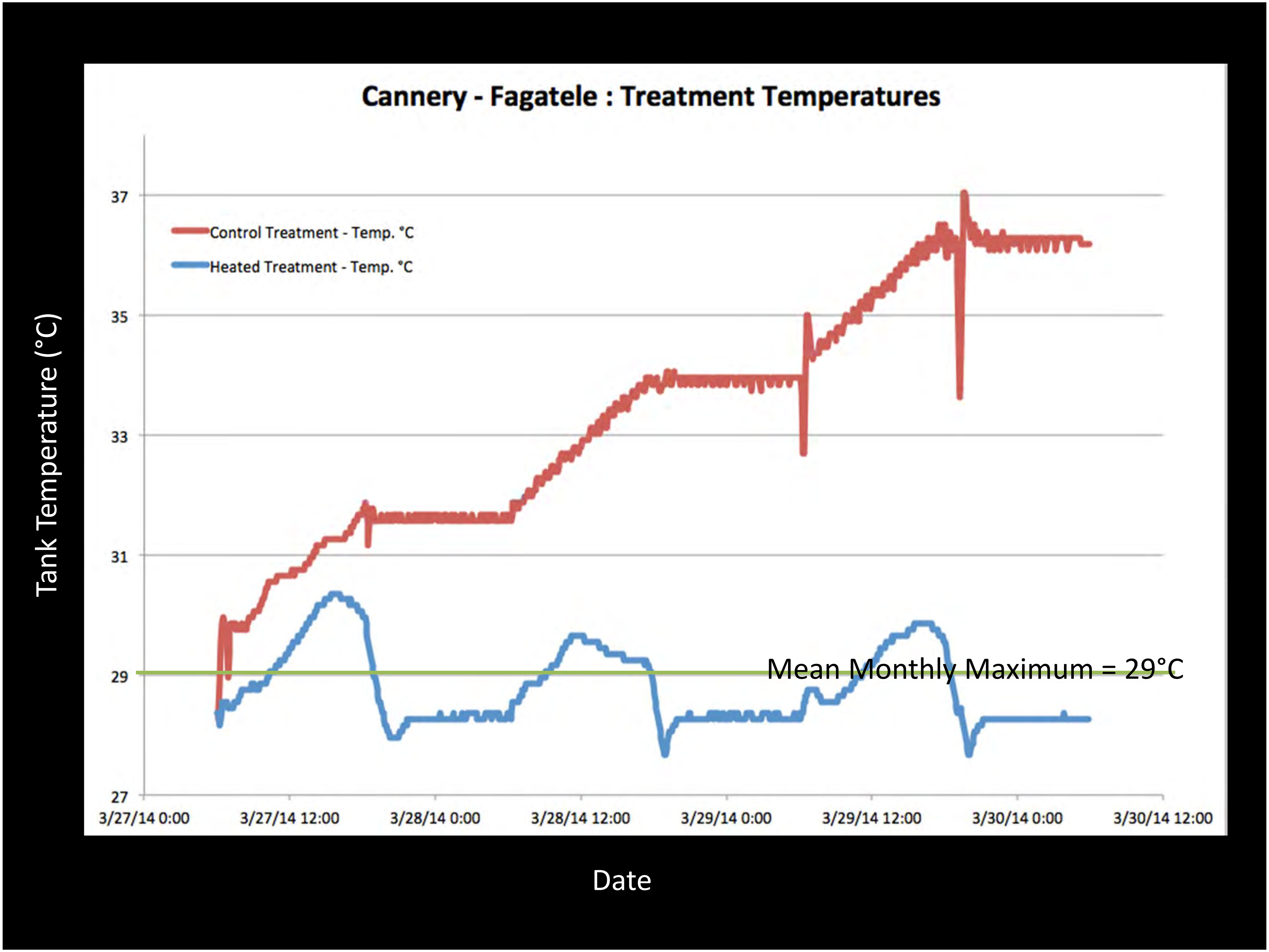
Project Priority	Site Name	Local Manager's Priority Ranking	Mangement Intervention	LBSP Impact	Shore
1	***Fagatele [IN1]***	***95***	***No-Take***	***Low***	***South***
1	Aunu'u [IN2]	112	No Reef Take	Low	South
1	Ofu Pools [IN3]	108	Subsistence Take	Low	South
1	Fagamalo [IN4]	79	No Take	Low	North
1	*Fagalua-Fagama'a [OUT1]*	*84*	*Open Access*	*Low*	*South*
1	Aunu'u [OUT2]	112	Open Access	Low	South
1	Olosega [OUT3]	90	Open Access	Moderate	South
1	Fagamalo [OUT4]	79	Open Access	Low	North
1	**Faga'alu**	**109**	**Open Access**	**Moderate**	**South**
1	Utulei/Tank Farm	93	Open Access	High/Moderate	South
1	**Faga'itua**	**103**	**Open Access**	**Moderate**	**South**
1	Vatia	108	Open Access	Moderate	North
1	**Pago Pago**	**80**	**Open Access**	**High**	**South**
1	Airport Pools	-	Open Access	High	South
1	Coconut Pt.	84	Open Access	High	South
1	Aua	98	Open Access	High	South

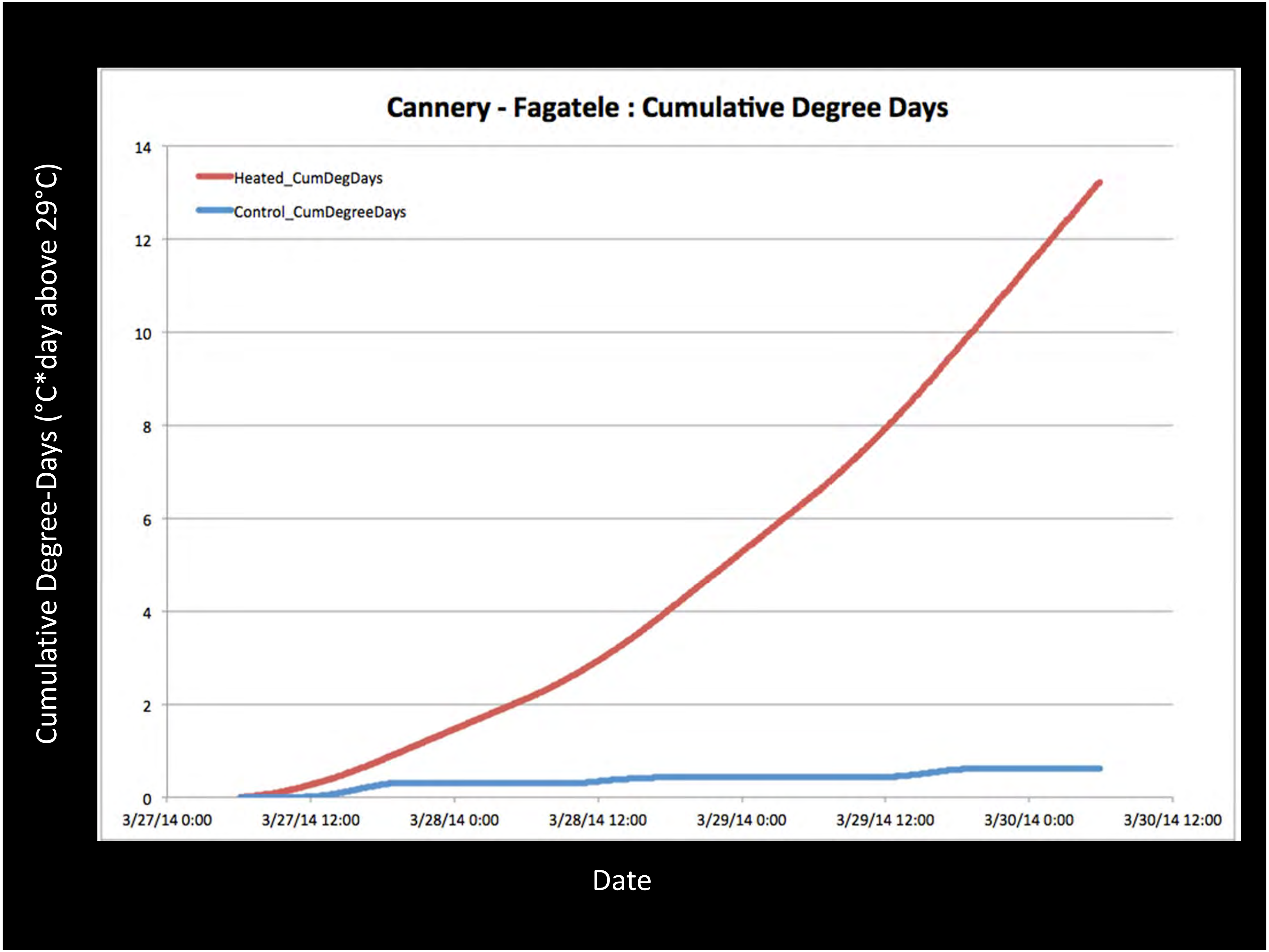

7


CORALWATCH
TABEL KESEHATAN
KARANG

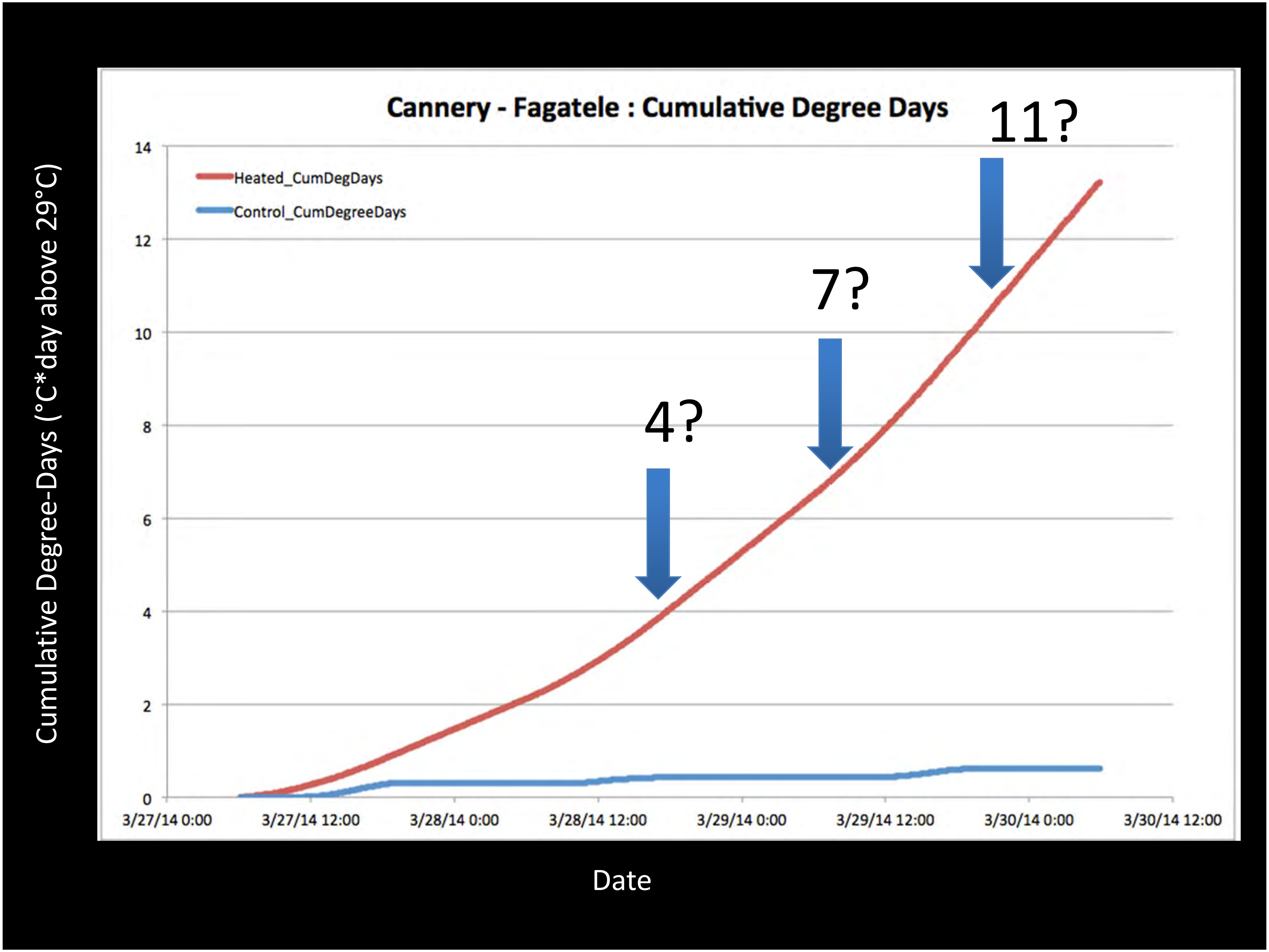

B1 B2 B3 B4 B5 B6 C1
CORALWATCH
TABEL KESEHATAN
KARANG
C3D


CORALWATCH
TABEL KESEHATAN
KARANG
C3D
H30

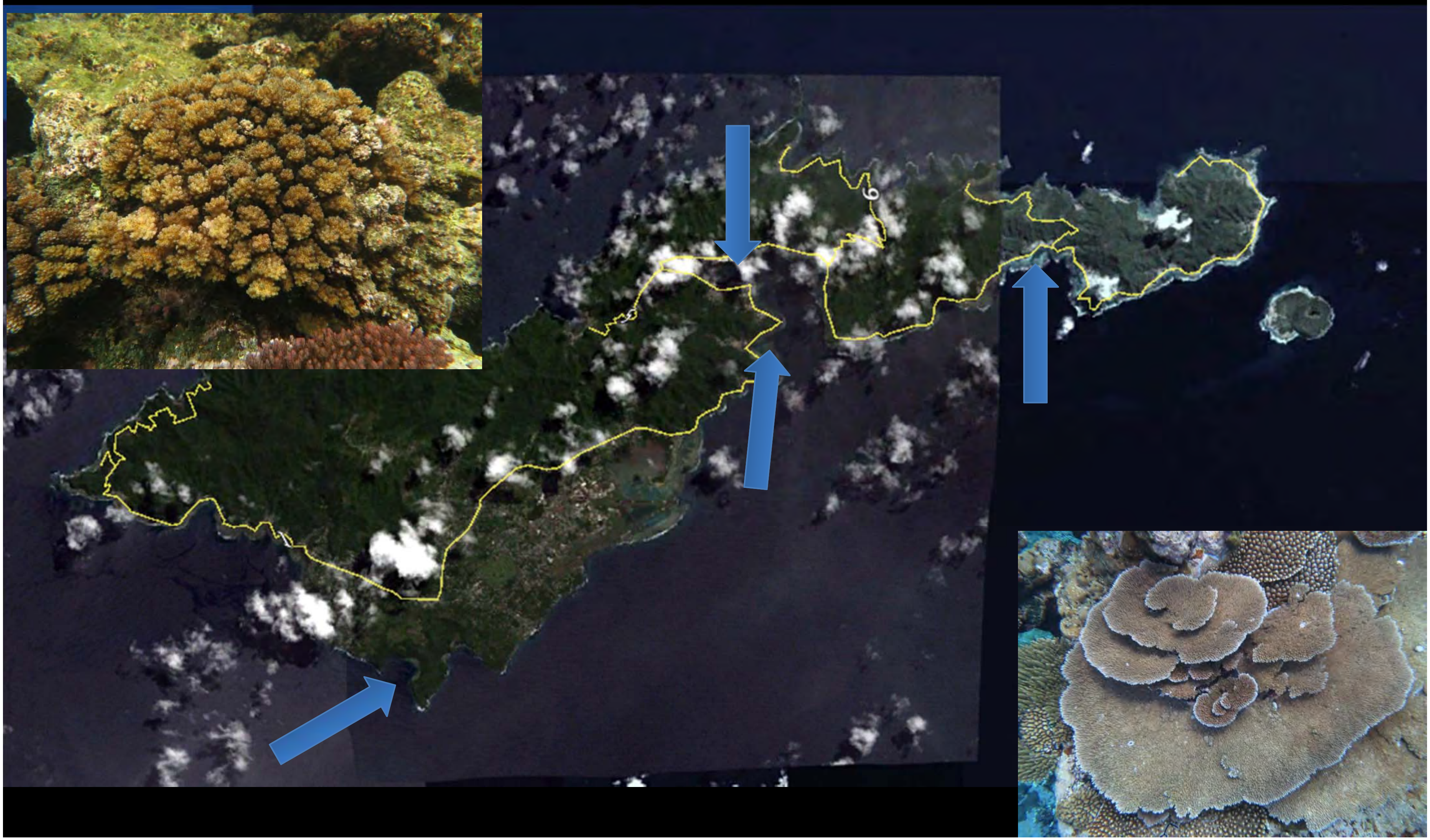

Cannery - Fagatele : Treatment Temperatures
Control Treatment - Temp. °C
Heated Treatment - Temp. °C
Mean Monthly Maximum = 29°C
Tank Temperature (°C)
37
35
33
31
29
27
3/27/14 0:00
3/27/14 12:00
3/28/14 0:00
3/28/14 12:00
3/29/14 0:00
3/29/14 12:00
3/30/14 0:00
3/30/14 12:00
Date


Cannery - Fagatele : Cumulative Degree Days
Heated_CumDegDays
Control_CumDegreeDays
0
2
4
6
8
10
12
14
3/27/14 0:00
3/27/14 12:00
3/28/14 0:00
3/28/14 12:00
3/29/14 0:00
3/29/14 12:00
3/30/14 0:00
3/30/14 12:00
Cumulative Degree-Days (°C*day above 29°C)
Date


CORALWATCH
TABEL KESEHATAN
KARANG
C3D
H30


Cannery - Fagatele : Cumulative Degree Days
Heated_CumDegDays
Control_CumDegreeDays
Cumulative Degree-Days (°C*day above 29°C)
Date
0
2
4
6
8
10
12
14
3/27/14 0:00
3/27/14 12:00
3/28/14 0:00
3/28/14 12:00
3/29/14 0:00
3/29/14 12:00
3/30/14 0:00
3/30/14 12:00
4?
7?
11?

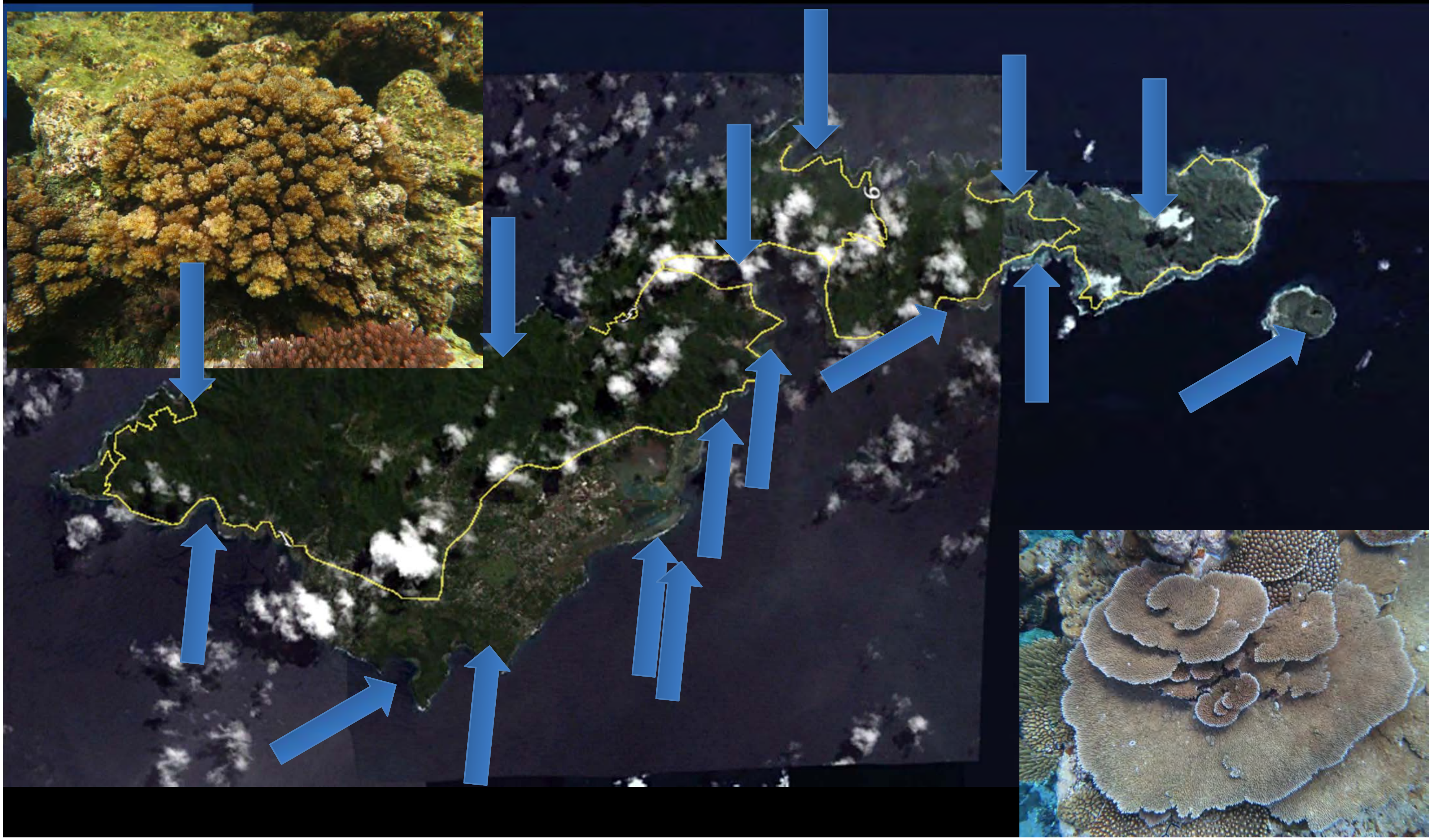
Mapping Coral Thermal Tolerance



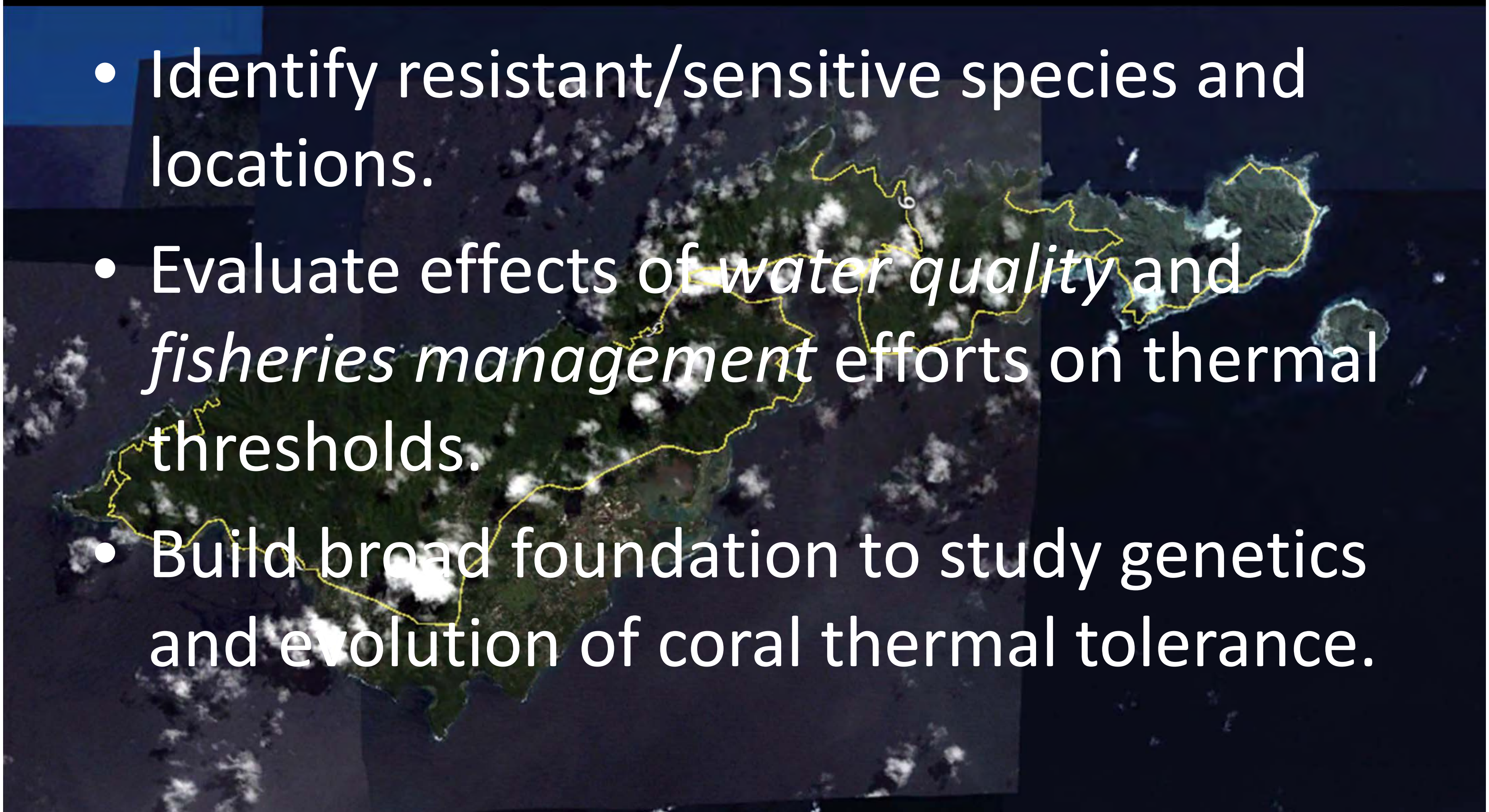
Empowering Local Science

- Designing rigs to keep costs down, give rigs to local institutions.
- Working with ASCC Marine Science Program.
- Hope to work with other local institutional partners that would like to runs these assays.
- Building Citizen Scientist data sharing portal.

Mapping Coral Thermal Tolerance: Working with local Partners!



Mapping Coral Thermal Tolerance



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- Evaluate effects of *water quality* and *fisheries management* efforts on thermal thresholds.
- Build broad foundation to study genetics and evolution of coral thermal tolerance.

Mapping Coral Thermal Tolerance

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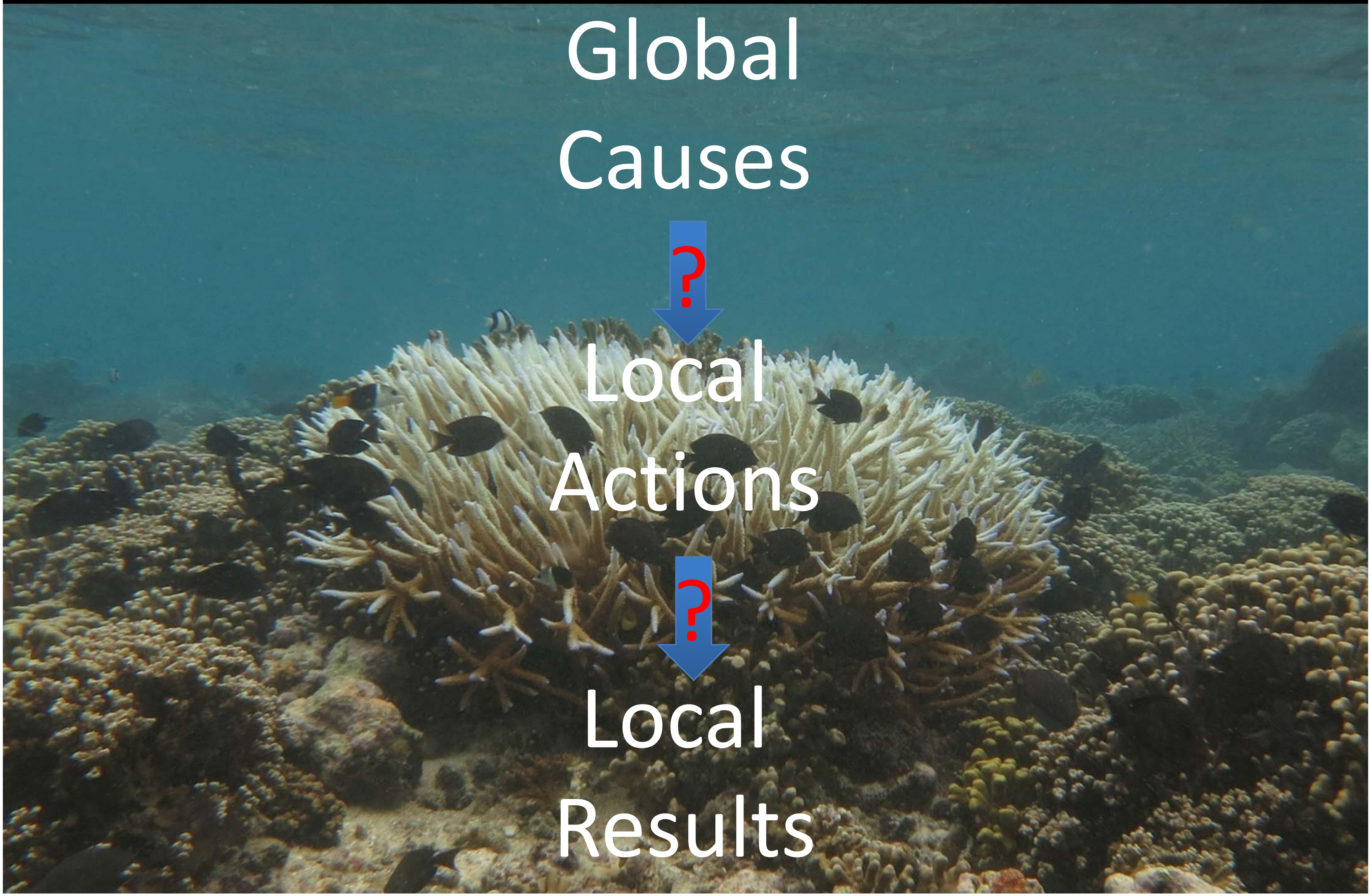
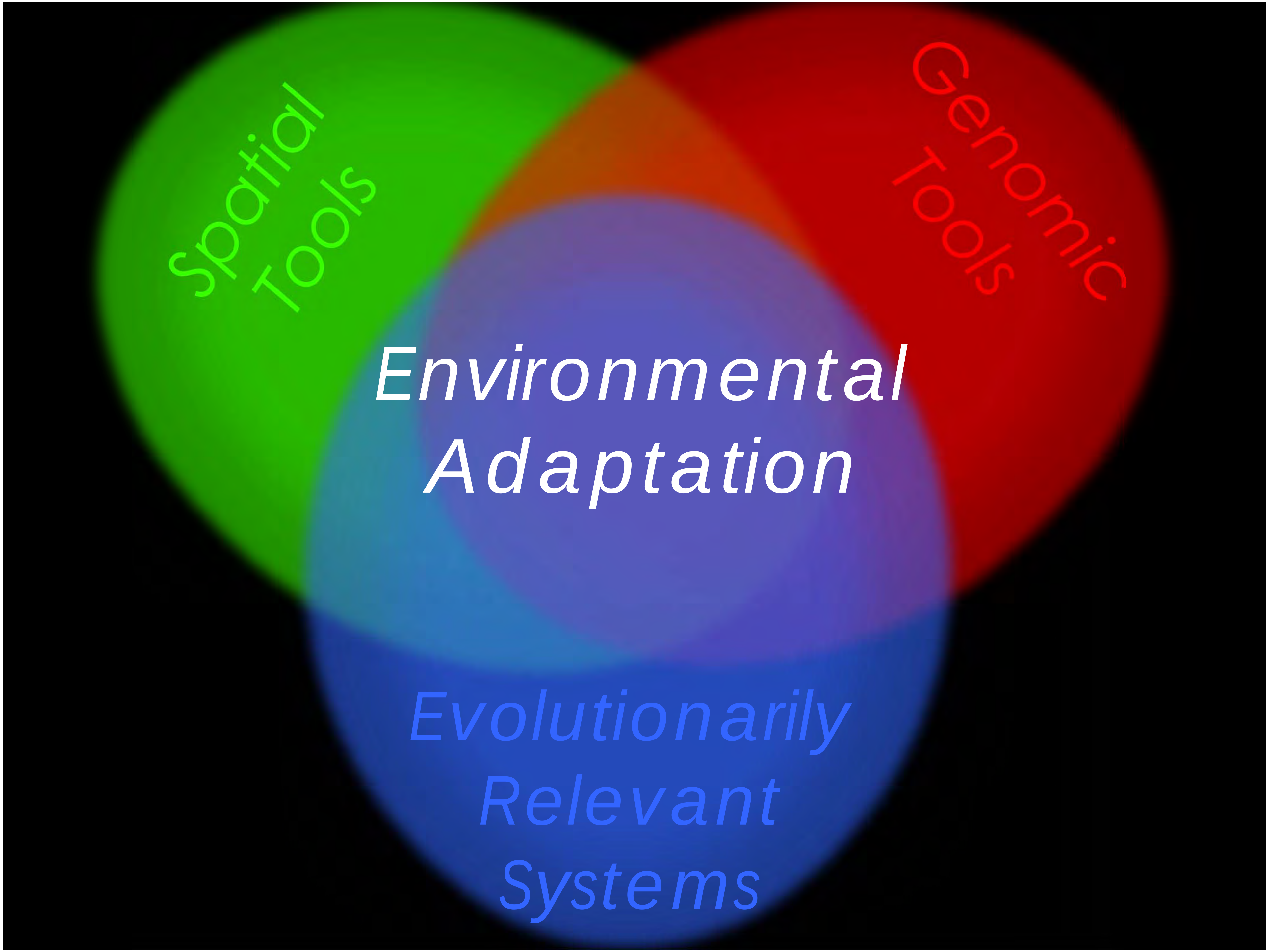
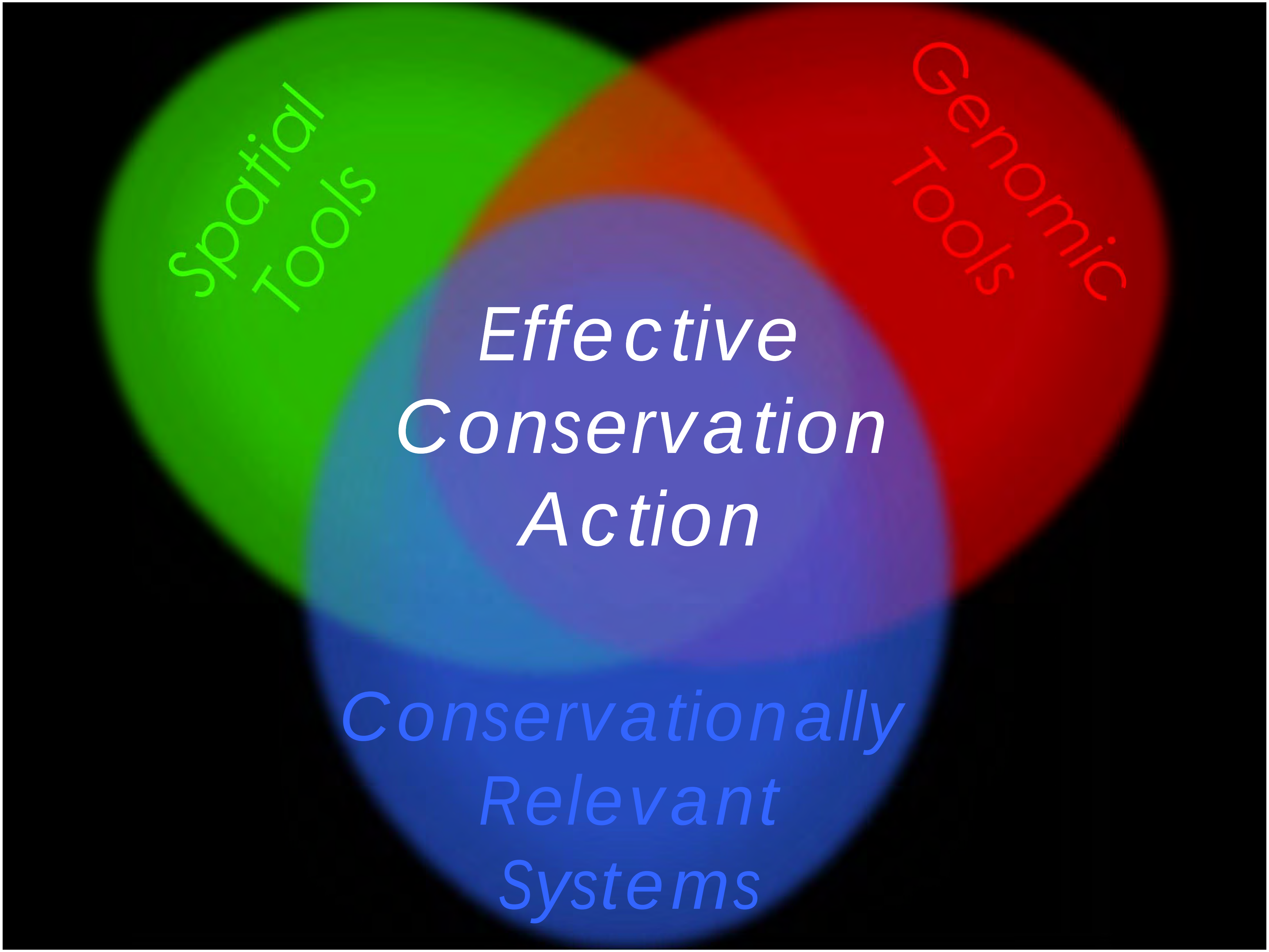
- Evaluate effects of *water quality* and *fisheries management* efforts on thermal thresholds.
- Build broad foundation to study genetics and evolution of coral thermal tolerance.

Rising Temperatures - Coral Bleaching




Spatial Tools
Genomic Tools
Environmental Adaptation
Evolutionarily Relevant Systems


Spatial Tools
Genomic Tools
Effective Conservation Action
Conservationally Relevant Systems

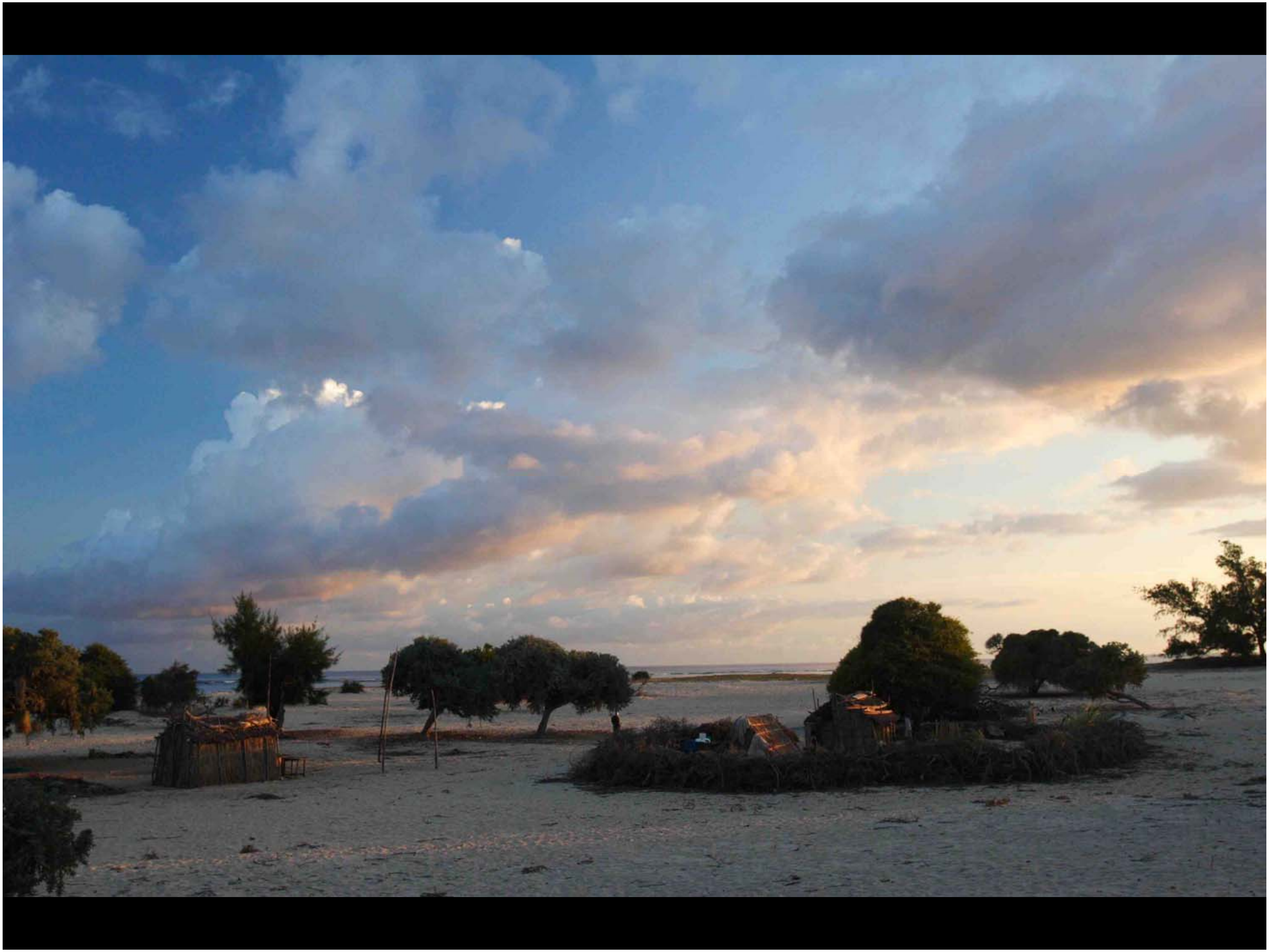
Effective Conservation Action


Conservation Science
in Madagascar

Community-Based Management

VELONDRIAKE


VELONDRIAKE
Ankindranoke
Vatoavo
Ampasimara
Agnolignoly
Tampolove
Nosy Be
Ansatsamandike
Bevato
Lobaho
Ambolimoke
Belavenoke
Antsatsamoroy
Lamboara
Ampasilava
Ampisorogna
Ankitambagna
Nosy Mitata
Andavadoaka
Nosy Andambatihy
Nosy Ve
Antseranananangy
Nosy Andragnombala
Nosy Hao



The Vezo

olo mitolo rano sy olo mipetsaky andriaky

people who ‘struggle with the sea and live by the coast’

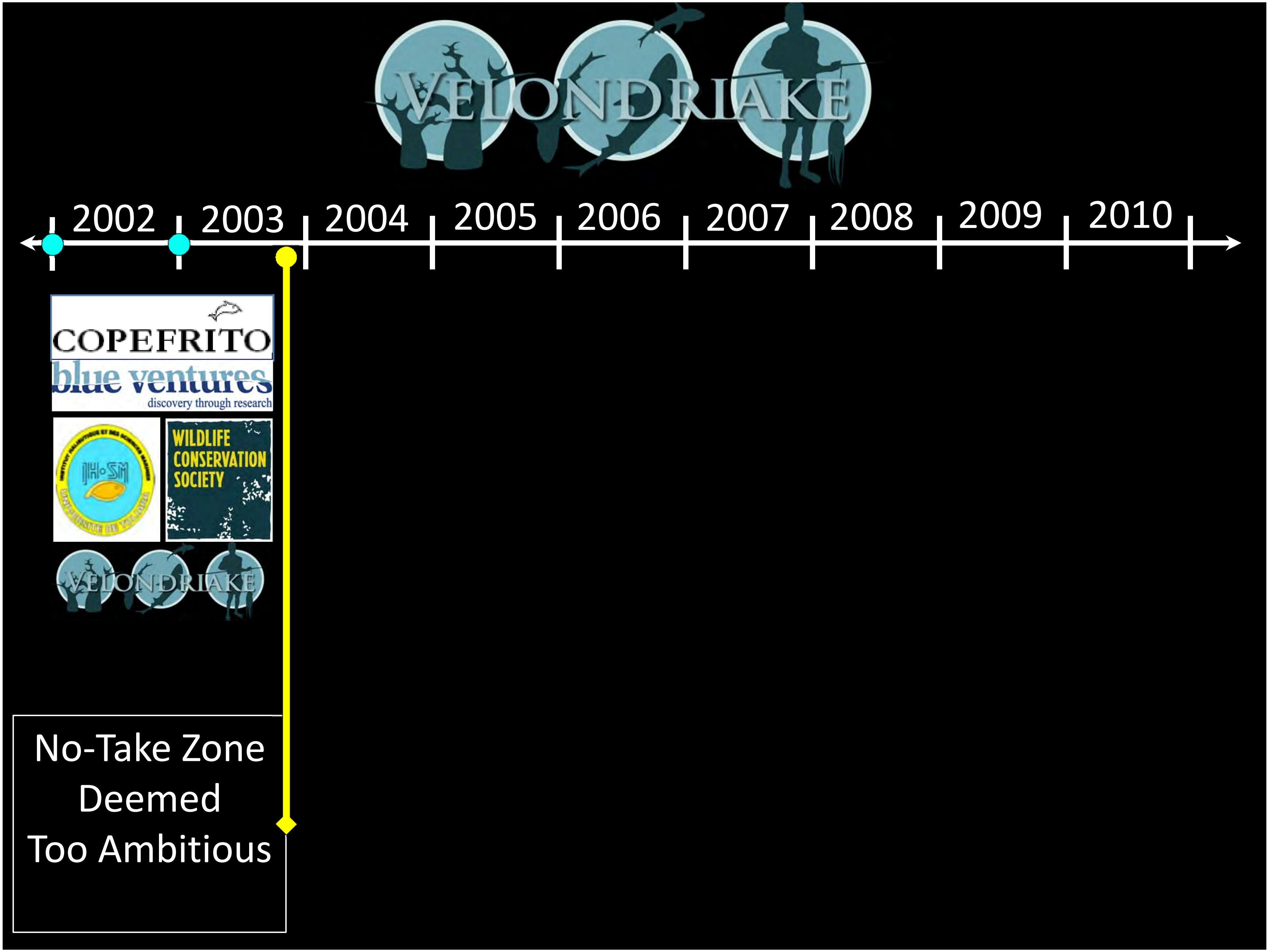
- Astuti (1995)

Traditional Management

VELONDRIAKE

2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010

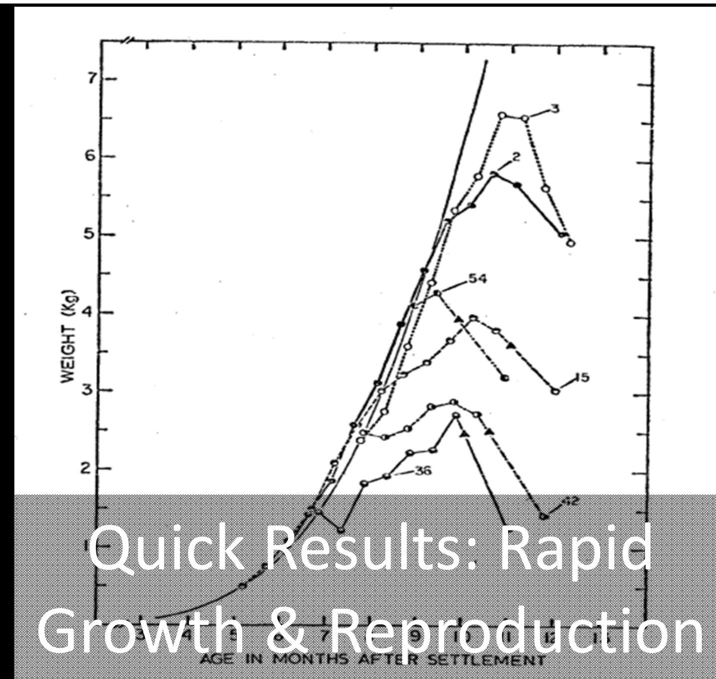
A long story of conservation…



VELONDRIAKE
2002
2003
2004
2005
2006
2007
2008
2009
2010
COPEFRITO
blue ventures
discovery through research
IH.SM
WILDLIFE CONSERVATION SOCIETY
VELONDRIAKE
No-Take Zone
Deemed
Too Ambitious

Next Try: Octopus

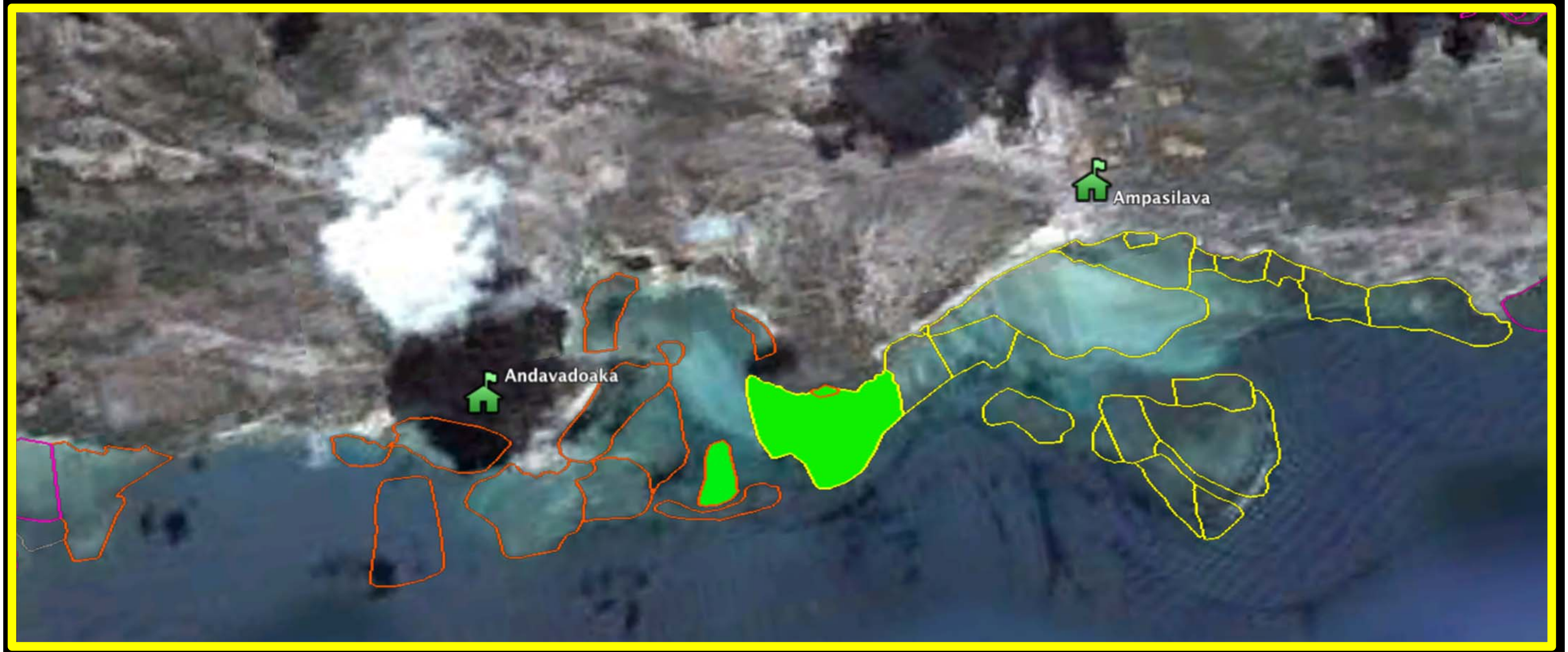
Cash Crop:
66-97% of Seafood Exports
(COPEFRITO 2011)



Quick Results: Rapid Growth & Reproduction

Egalitarian Access:
Men and Women Fish

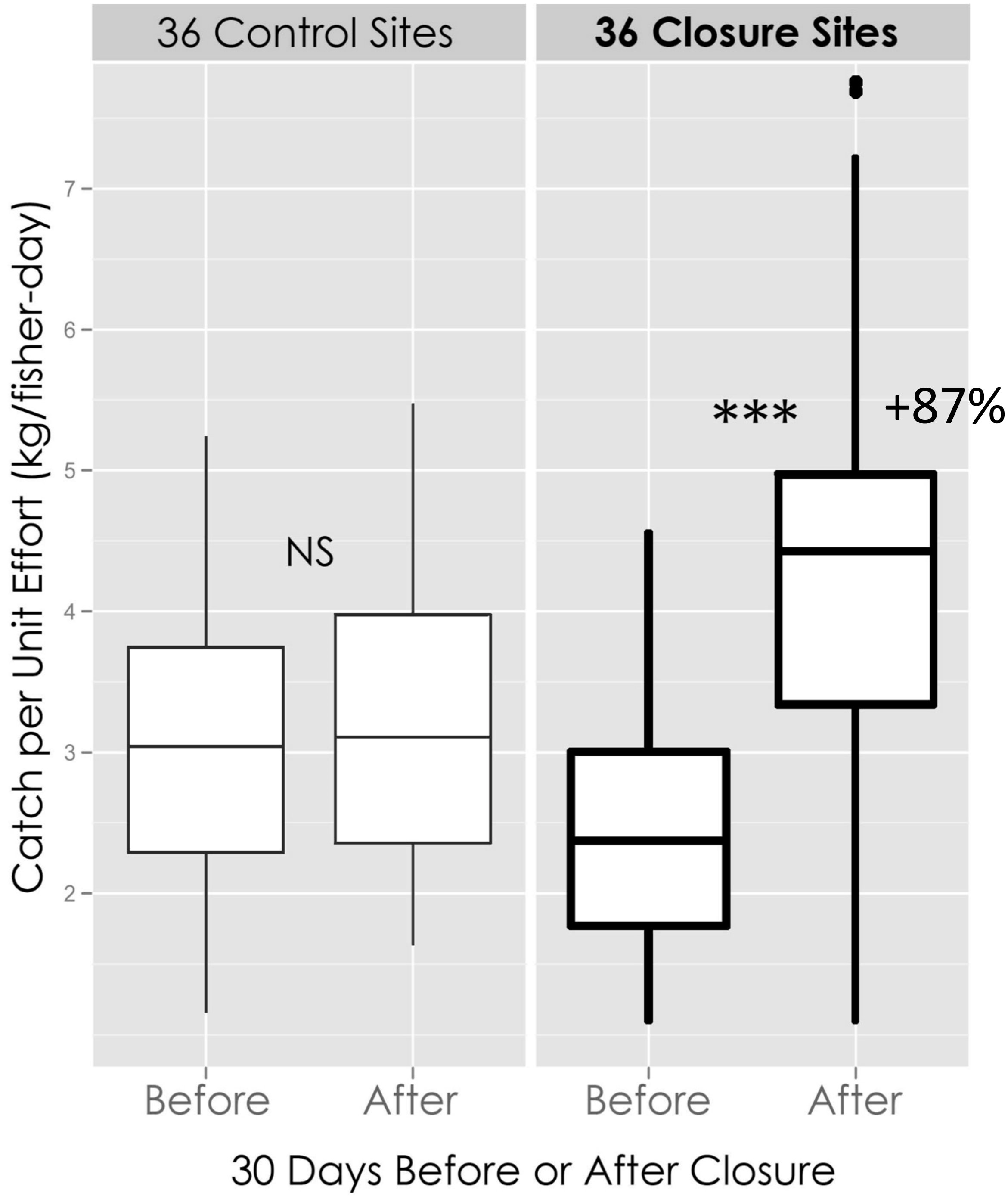
Octopus cyanea Closures



- Supporting village(s) work with Velondriake Committee to choose area
- Mean ~24% of village's octopus harvest area
- 3 months (2-7 months)

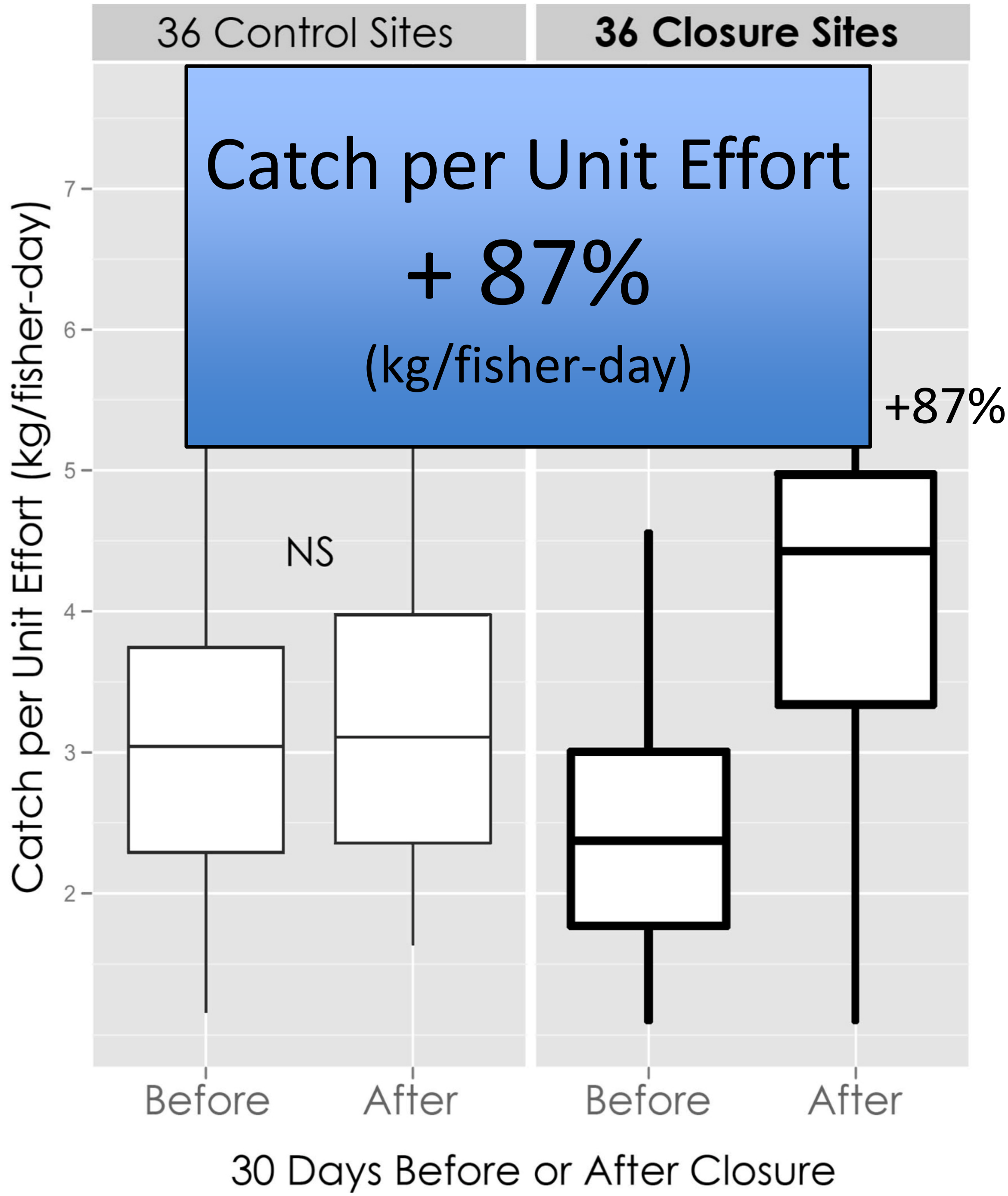
Catch per Unit Effort (CPUE) (kg/fisher-day):

How much did each person catch each day?



Catch per Unit Effort (CPUE) (kg/fisher-day):

How much did each person catch each day?



Do Octopus Closures Increase Catch?

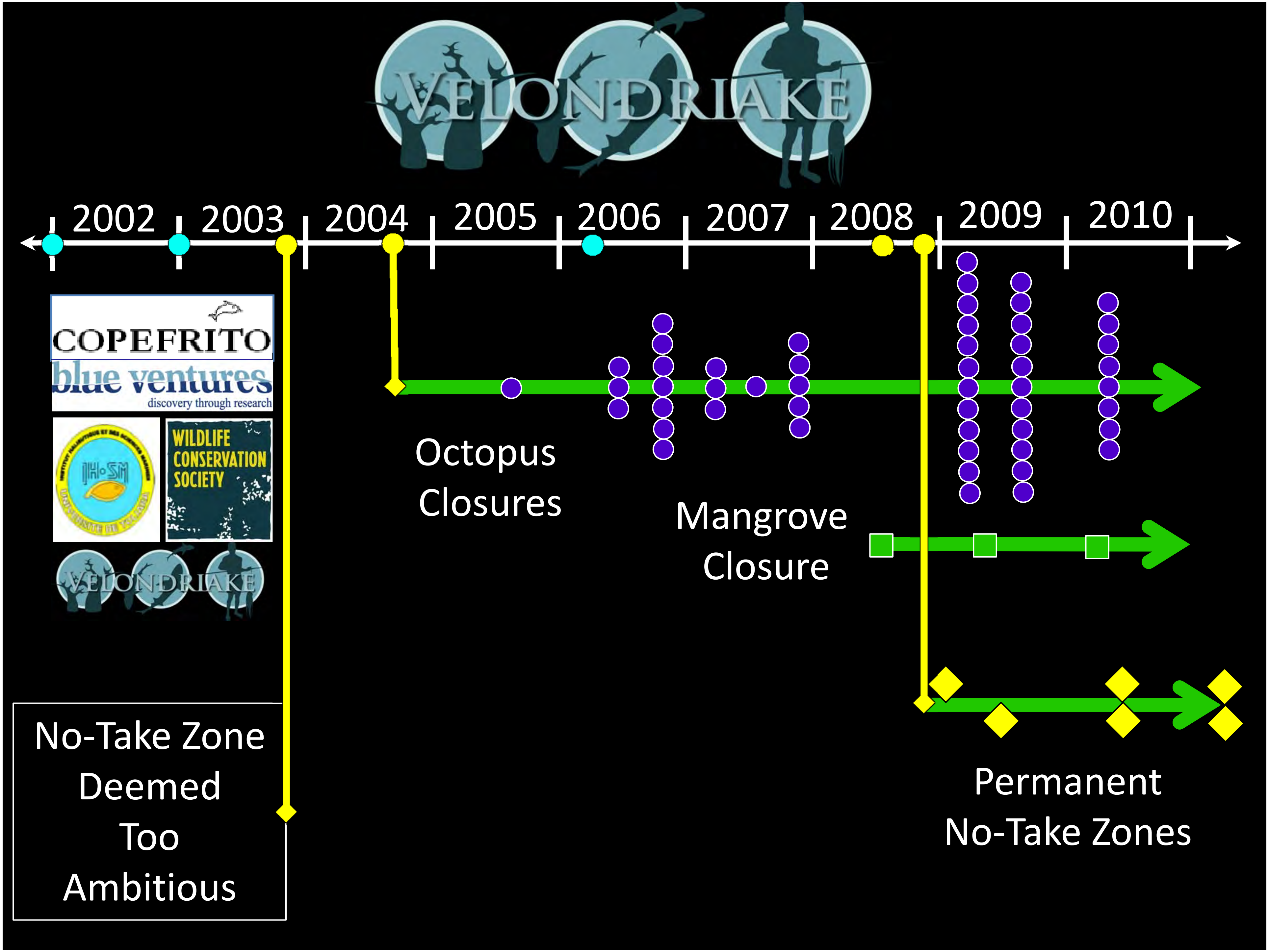
Yes.

Catch per Unit Effort

30 Days Before:
2.4 kg/fisher-day

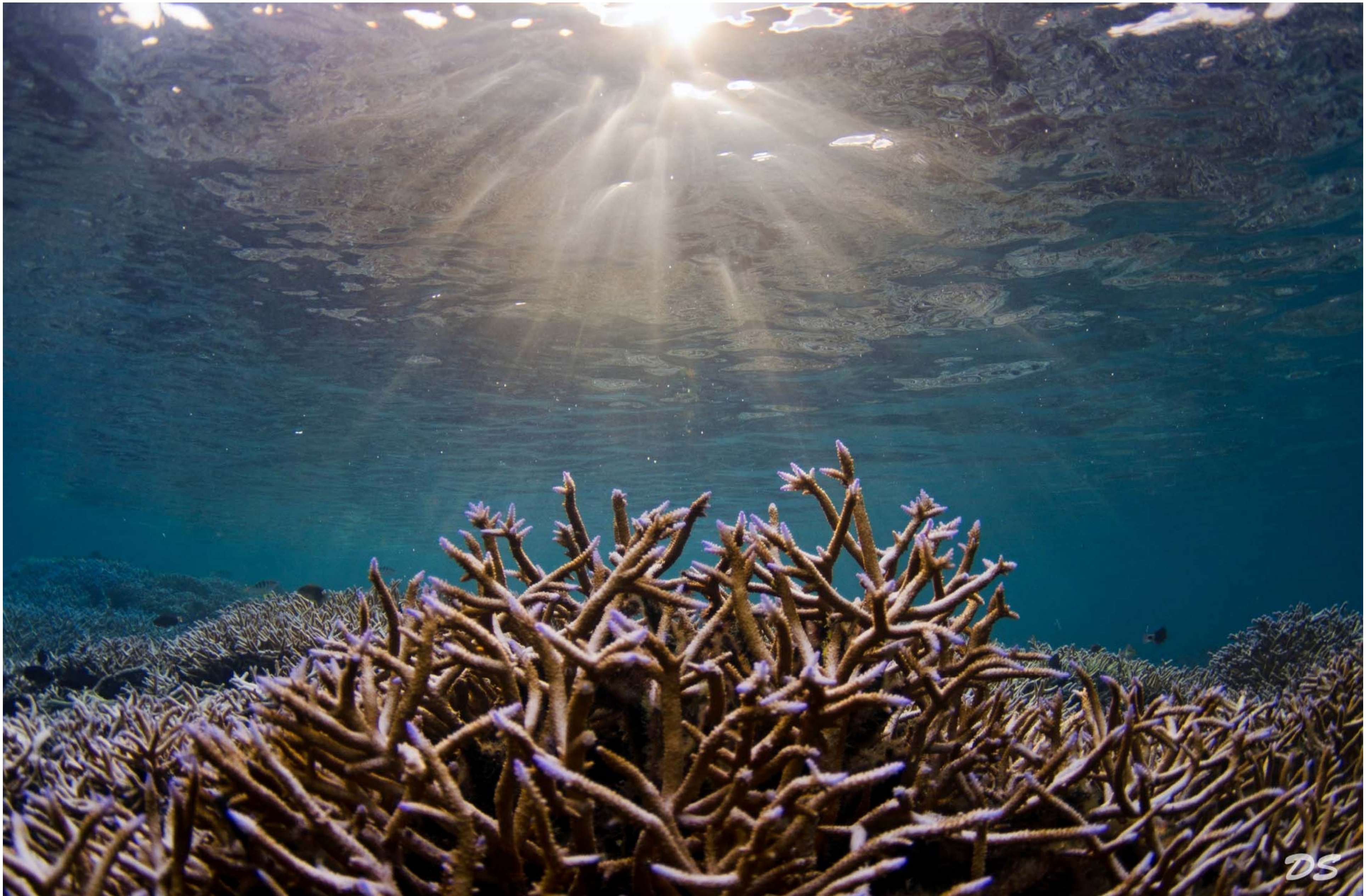
30 Days After:
4.4 kg/fisher-day


Fishery Benefits
Economic Benefits
Attitudes & Perceptions
Institutional Capacity



VELONDRIAKE
2002
2003
2004
2005
2006
2007
2008
2009
2010
COPEFRITO
blue ventures
discovery through research
WILDLIFE CONSERVATION SOCIETY
IH.SM
VELONDRIAKE
Octopus Closures
Mangrove Closure
No-Take Zone Deemed Too Ambitious
Permanent No-Take Zones


Using short-term reserves to catalyze community based managment
Begin by showing demonstrable benefits from management and thereby build confidence in management actions, community buy-in, and institutional capacity for broader conservation efforts.



Questions?

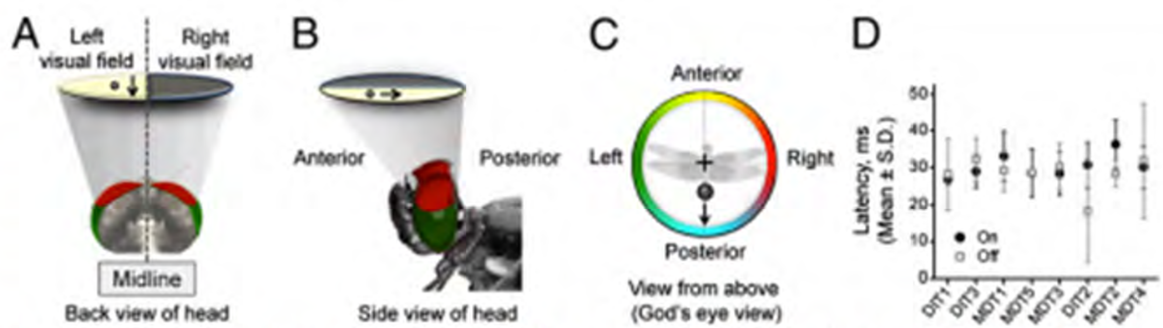


Fig. 1. Small moving targets rapidly activate TSDNs. View of a *L. luctuosa* head from behind (*A*) and side (*B*) where the gray cone symbolizes the visual field of the dorsal area. The eyes are false colored in red (dorsal eye) and green (rest of the eye). A target (flying insect) moving above the dragonfly from front to back crossing the left visual field (yellow area) in the direction indicated by the arrow, excites the TSDN MDT1. (*C*) Polar plot with the "God's eye view" reference used to display target directions, i.e., the target movement shown in *A* and *B* is here shown as a vector pointing down to the blue zone. (*D*) Summary of the latencies. The latencies obtained for each TSDN type were not significantly different from each other (one-way ANOVA).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