Adaptive, Ecosystem-Based Management of the Great Barrier Reef Marine Reserve Network

Australian Government
Great Barrier Reef Marine Park Authority

A globally significant demonstration of the benefits of networks of marine reserves

Laurence McCook,
Pew Fellow in Marine Conservation, ARC Centre of Excell. Coral Reef Studies
(& Great Barrier Reef Marine Park Authority),
&
Very many GBR scientists

Pew Fellows Program in Marine Conservation

ARC Centre of Excellence Coral Reef Studies

our great barrier reef let's keep it great

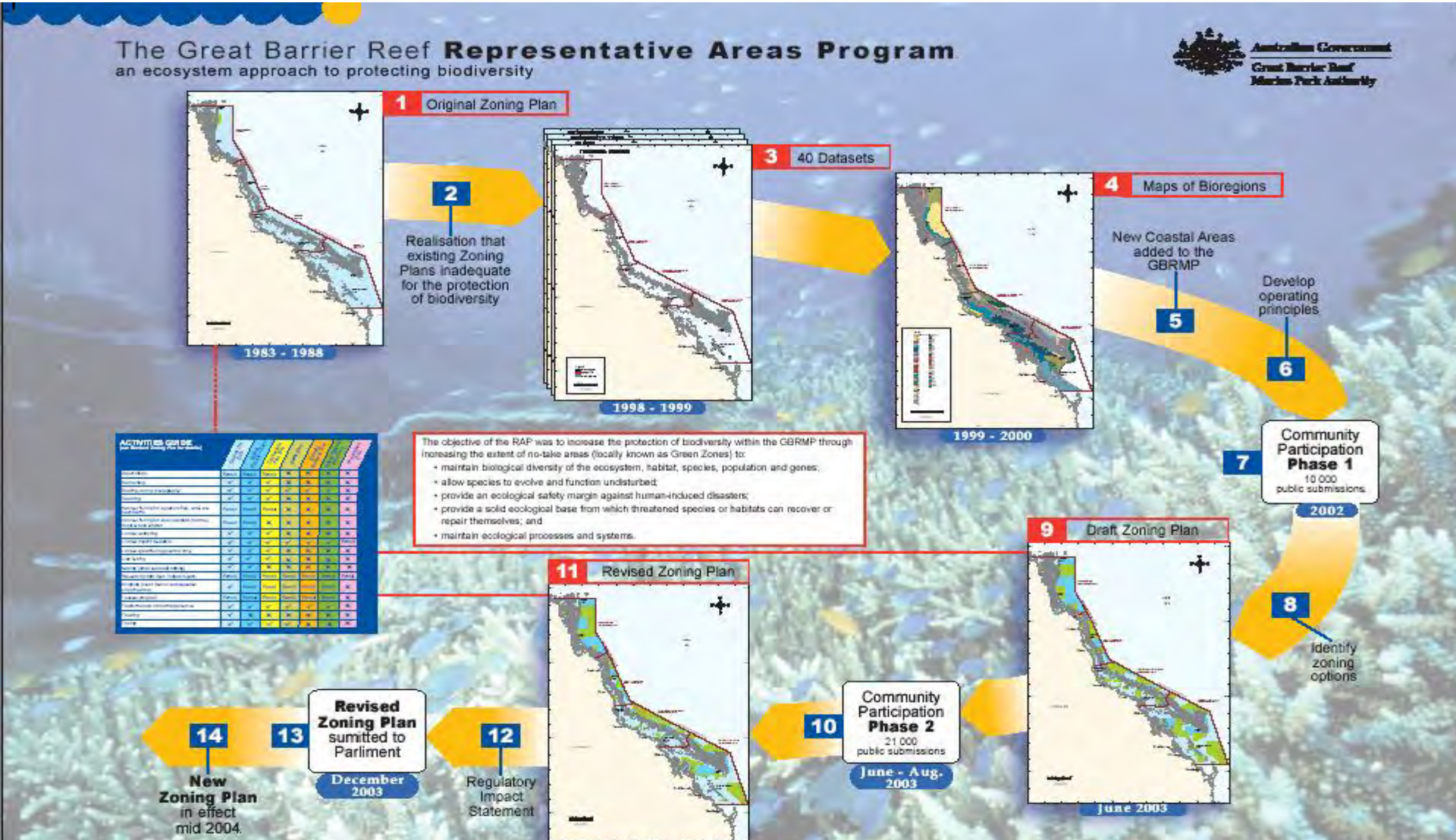
A science & management team effort & consensus statement

- Tony Ayling
- Mike Cappo
- J. Howard Choat
- Richard D. Evans
- Debora M. De Freitas
- Michelle Heupel
- Terry P. Hughes
- Geoffrey P. Jones
- Bruce Mapstone
- Helene Marsh
- Morena Mills
- Fergus Molloy
- C. Roland Pitcher
- Robert L. Pressey
- Garry R. Russ
- Stephen Sutton
- Hugh Sweatman
- Renae Tobin
- David R. Wachenfeld
- David H. Williamson

- GBRMPA & Pew Fellows Program
- AIMS
- ARC Centre of Excellence for Reef Studies
- MTSRF & RRRC
- JCU Marine & Tropical Biology &
- JCU School of Earth & Environmental Sciences
- CSIRO Marine & Atmospheric Sciences
- FRDC, QFMA
- MANY GBRMPA STAFF: esp
- Mick Bishop, James Aumend, Reg Parsons, Mark Read, Spatial Data Centre
- James Innes, Ingrid van Putten & GBRMPA Social-Economics team
- S.Gaines, J. Lubchenco, K.Grorud_Colvert, S. Lester,
- N.Stoeckl, O. Stegeman and G. Lange

Generous contributions of EXTENSIVE Unpublished data

Outcomes: a tribute to good process….



Outline:

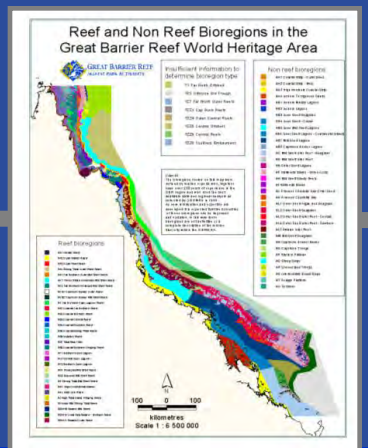
- Background: EBM, Adaptive Management, etc
- Results:

  - Fish & sharks – direct effects (+/- 2004)
  - Corals & Foodwebs – indirect effects
  - Non-reef habitats & shoals;
  - Species of Conservation Concern: Dugong & Turtles;
  - Compliance
  - Economics
  - Social impacts

- Take Homes: Reef benefits…

GBR: A globally significant case study of paradigms of marine reserve networks

- Scientific significance:
  - LARGE, replication, before-after, no-entry zones; gradients, background science.
- Best practice implementation - CARR, Operating Principles etc;
- Regional scale
- Lots of results - new & old zoning;
- Exceptional breadth: fish → compliance → $$
- *(Not including process, governance, etc.)*
- *Joint management integrated with GBR Coast Marine Park*



Ecosystem-based management

GBRMP Act now defines "ecosystem-based management" as:

"An integrated approach to the management of an ecosystem and of matters affecting that ecosystem with the primary goal of maintaining ecological processes, biodiversity and functioning biological communities".

Spatial Management within Ecosystem Based Management:

- Fundamental component of effective ecosystem-based management

  BUT….

- Only 1 element of integrated package of management strategies used in the GBR to sustain biodiversity & different uses;

Management Approaches

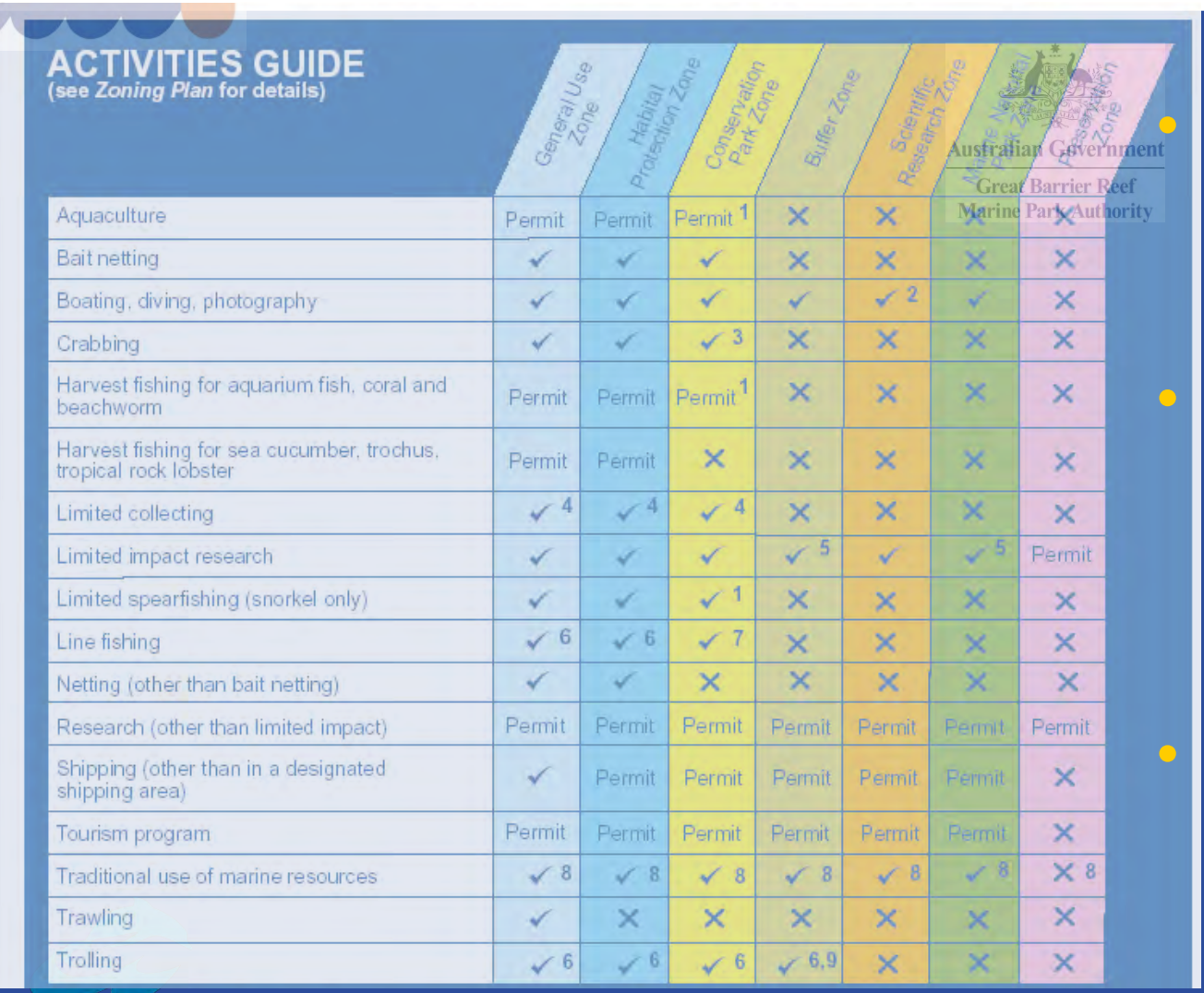
- Education & Community Partnerships
- Water Qual Partnerships, incentives & regulations
- Zoning;
- Permitting;
- Environmental Impact Management;
- Compliance & Enforcement:
- Dugong protection areas;
- Fisheries Management Plans: Gear Restrictions (Bycatch reduction); Size Limits; Bag Limits
- Temporal closures (eg. fish spawning)
- Economic instruments (eg. Environment Management Charge)
- Industry Codes of Practice
- Assessment & Influencing activities outside jurisdiction (EPBC);

Many important „activities' NOT primarily managed by zoning :

- Defence
- Shipping
- High use tourism areas
- Research
- Indigenous use
- Special Management Areas
- Spawning closures
- World Heritage Area

These are better addressed by other planning approaches

More than just no-take zones



ACTIVITIES GUIDE
(see *Zoning Plan* for details)

	General Use Zone	Habitat Protection Zone	Conservation Park Zone	Buffer Zone	Scientific Research Zone	Marine National Park Zone	Preservation Zone
Aquaculture	Permit	Permit	Permit [1]	✗	✗	✗	✗
Bait netting	✓	✓	✓	✗	✗	✗	✗
Boating, diving, photography	✓	✓	✓	✓	✓ [2]	✓	✗
Crabbing	✓	✓	✓ [3]	✗	✗	✗	✗
Harvest fishing for aquarium fish, coral and beachworm	Permit	Permit	Permit [1]	✗	✗	✗	✗
Harvest fishing for sea cucumber, trochus, tropical rock lobster	Permit	Permit	✗	✗	✗	✗	✗
Limited collecting	✓ [4]	✓ [4]	✓ [4]	✗	✗	✗	✗
Limited impact research	✓	✓	✓	✓ [5]	✓	✓ [5]	Permit
Limited spearfishing (snorkel only)	✓	✓	✓ [1]	✗	✗	✗	✗
Line fishing	✓ [6]	✓ [6]	✓ [7]	✗	✗	✗	✗
Netting (other than bait netting)	✓	✓	✗	✗	✗	✗	✗
Research (other than limited impact)	Permit	Permit	Permit	Permit	Permit	Permit	Permit
Shipping (other than in a designated shipping area)	✓	Permit	Permit	Permit	Permit	Permit	✗
Tourism program	Permit	Permit	Permit	Permit	Permit	Permit	✗
Traditional use of marine resources	✓ [8]	✓ [8]	✓ [8]	✓ [8]	✓ [8]	✓ [8]	✗ [8]
Trawling	✓	✗	✗	✗	✗	✗	✗
Trolling	✓ [6]	✓ [6]	✓ [6]	✓ [6,9]	✗	✗	✗

Australian Government
Great Barrier Reef Marine Park Authority

- 7 marine zones + Commonwealth Island zone,
- each clear objective to manage different aspects of use and conservation;
- challenge for monitoring...

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Zoning Plan- pre 2004

Zoning Plan- 2004

117,000 km²

	Revised ZP	Old ZP
Preservation Zone – 'no go'	0.2%	(0.1%)
Marine Nat'l Park - no-take	33.3%	(4.6%)
Scient. Research	0.05%	(0.01%)
Buffer Zone – trolling only	2.9%	(0.1%)
Conservat'n Park – limited fishing	1.5%	(0.6%)
Habitat Protect'n – no trawling (66%)	28.2%	(15.2%)
General Use – all reasonable uses	33.8%	(77.9%)

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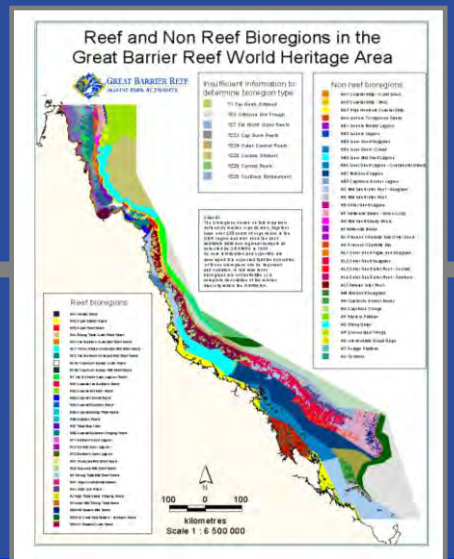
2004 New Zoning Plan: A global standard for marine protection

- 33% protected in no-take areas;
- **≥ 20% of each of ~70 bioregions;**
- **~66% no-trawl**

Process:

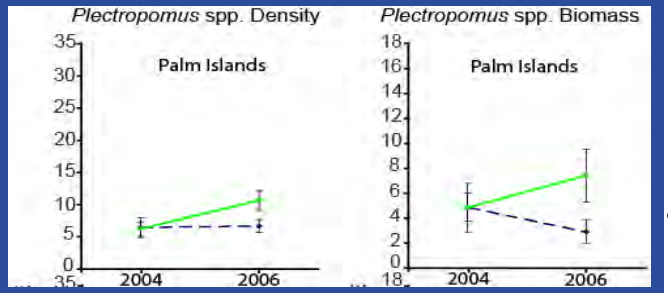
- 11 biophysical operating principles
- 4 social & economic operating principles
- Community consultation – 31,500 submissions



Monitoring the zoning network- Target fish

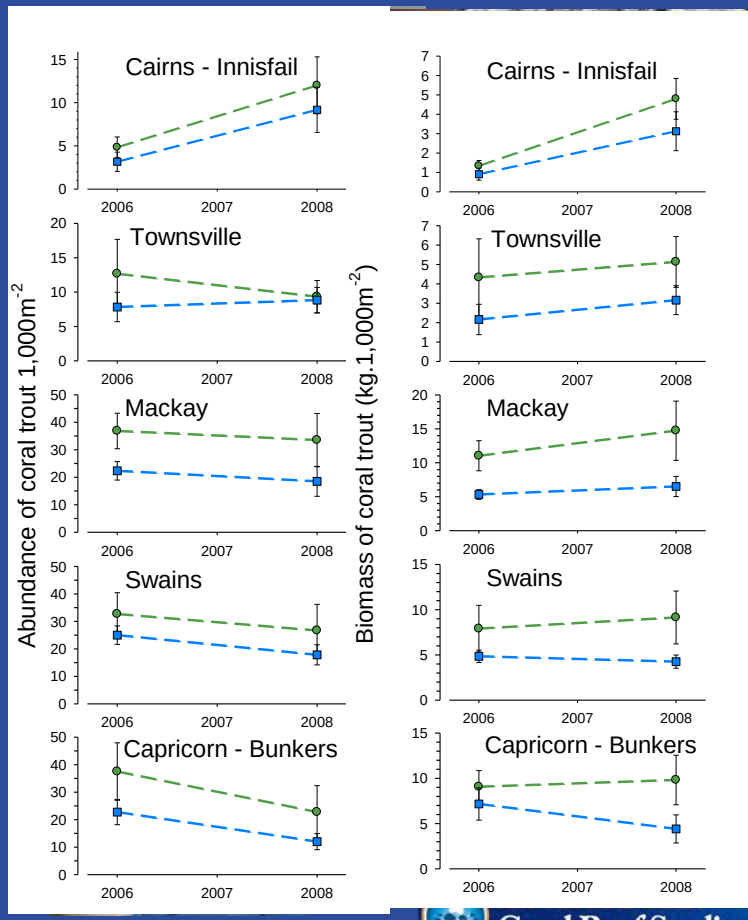
A. Inshore Reefs

Numbers Biomass



B. Offshore Reefs

Numbers Biomass



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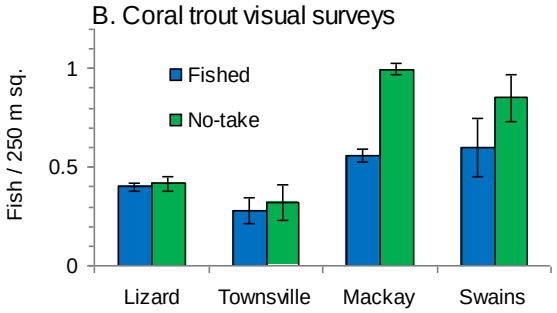
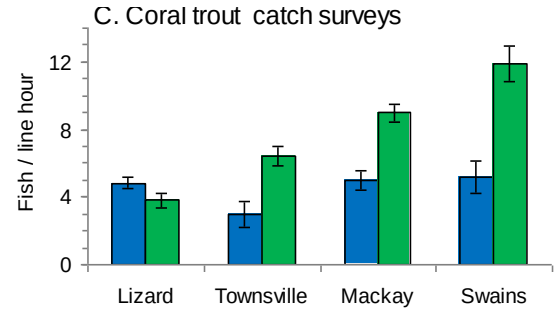
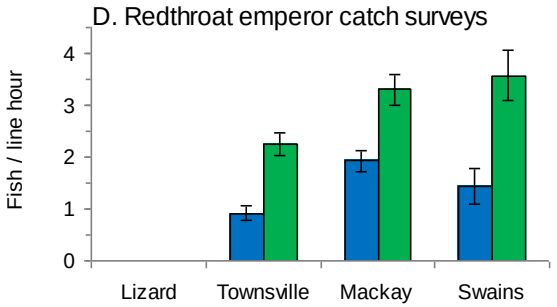
Monitoring the zoning network- Target fish- Previous Zoning

Offshore Reefs:

Effects of Line Fishing Experiment;

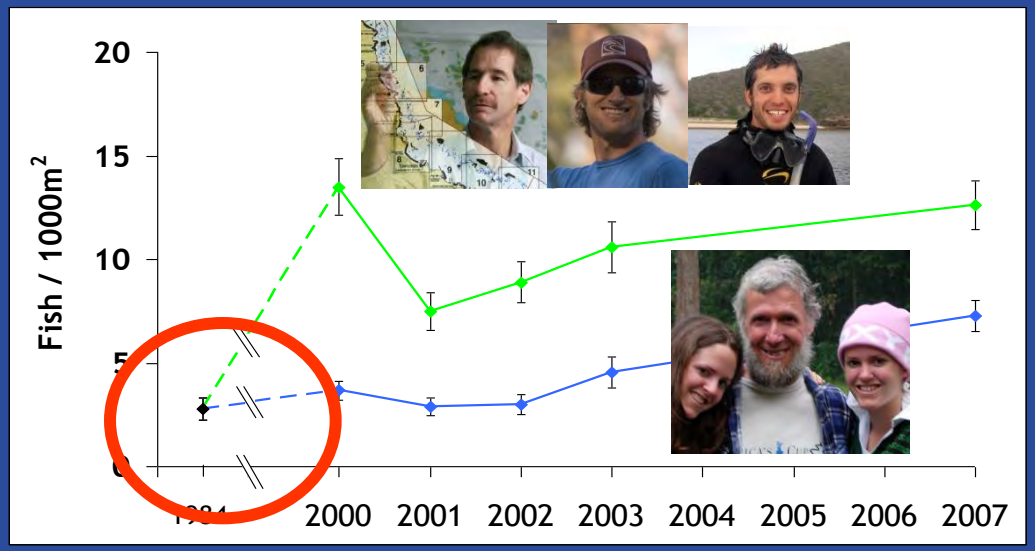






Inshore Reefs:

Williamson et al. 2004; Evans & Russ 2004



Clear, widespread evidence for long-term benefits of no-take zones

- Unpublished data
- ELF modelling of management
- **Depletion by 1984…**

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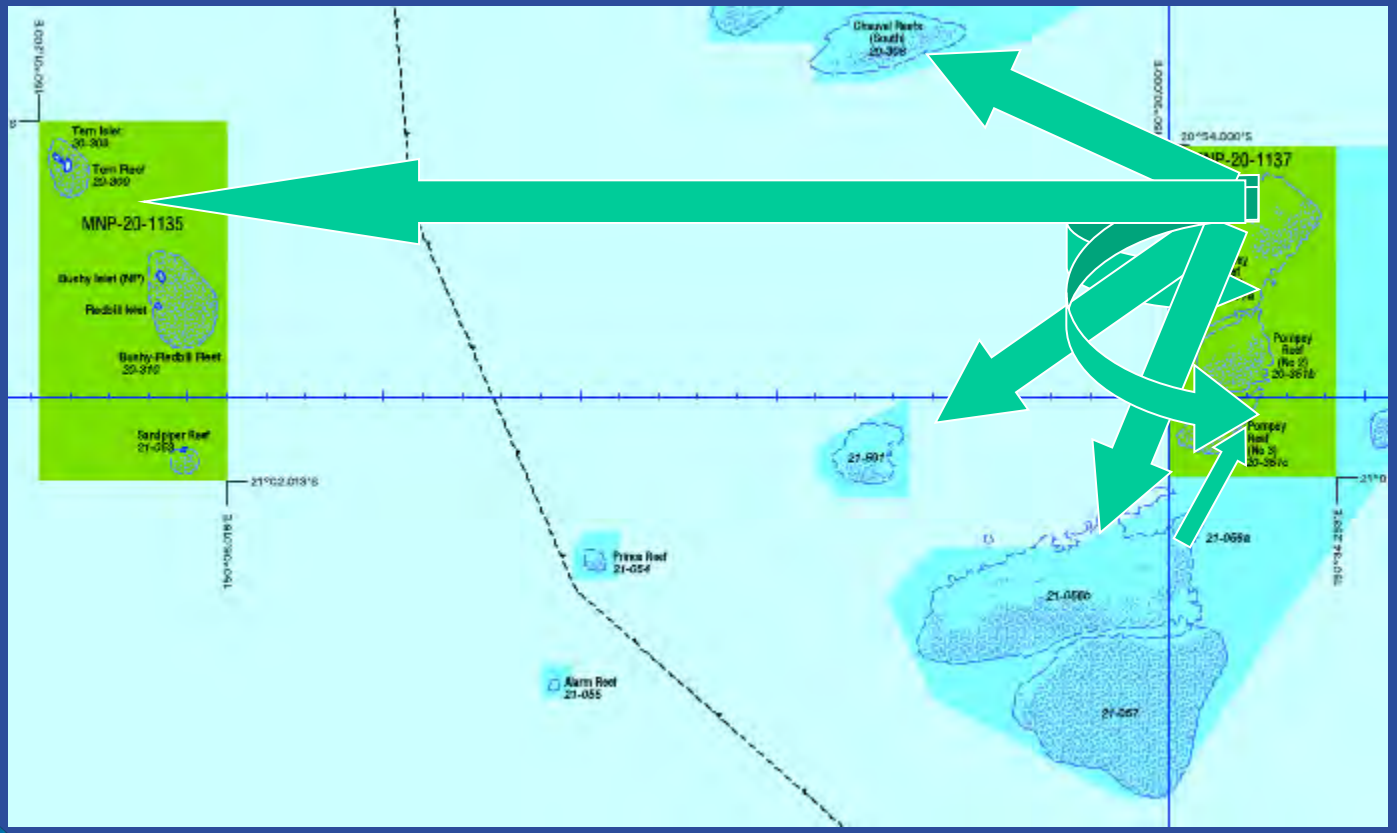
Effects on ecosystem-wide fish populations:

- Benefits to other reserves; to fished areas;

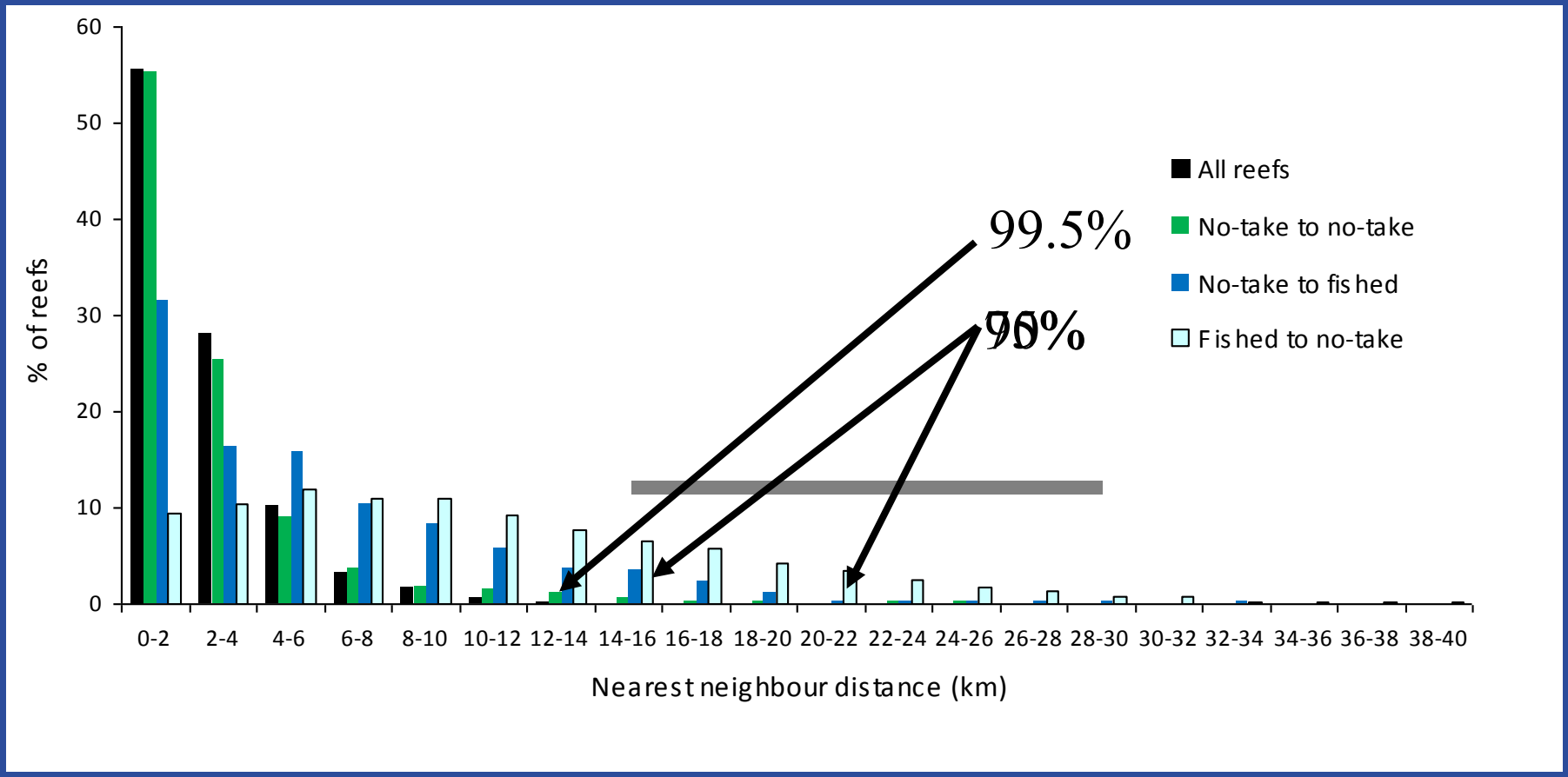


Effects on ecosystem-wide fish populations:

- Benefits to other reserves; to fished areas;
- Limited adult export (esp. coral trout);
- Larval exchange & subsidies:
  - Transport between reefs – Jones et al... ongoing
  - Relative reproductive output – reserves : fished reefs **Big fish -> disproportionate reproductive output**;

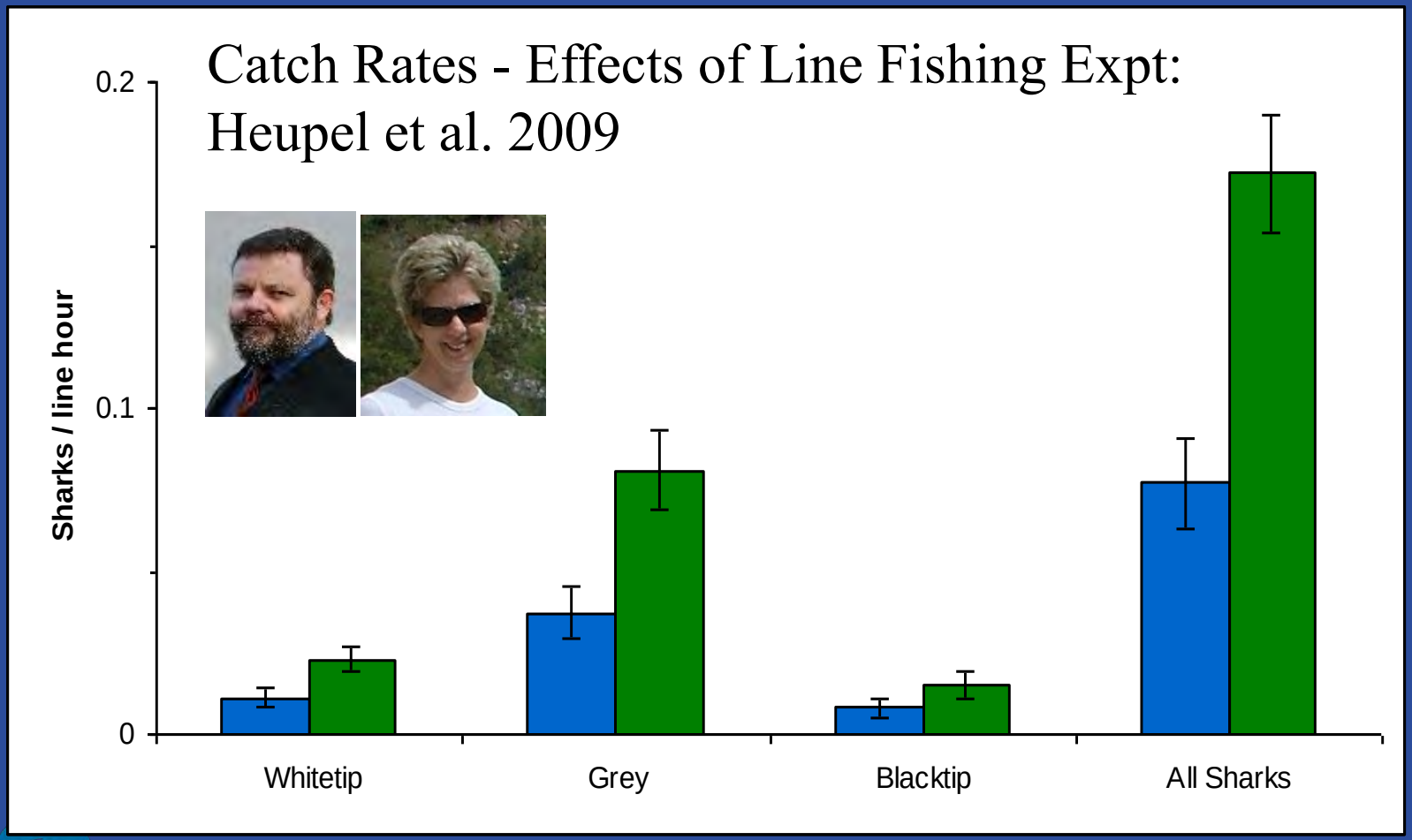
  e.g. Green 2.5x blue zones; scaling by area => fished reefs no loss of reproductive input (Evans et al 08); Russ et al ongoing;
  - Dispersal distances

Connectivity & mpa networks:
Maintain range of dispersal distances

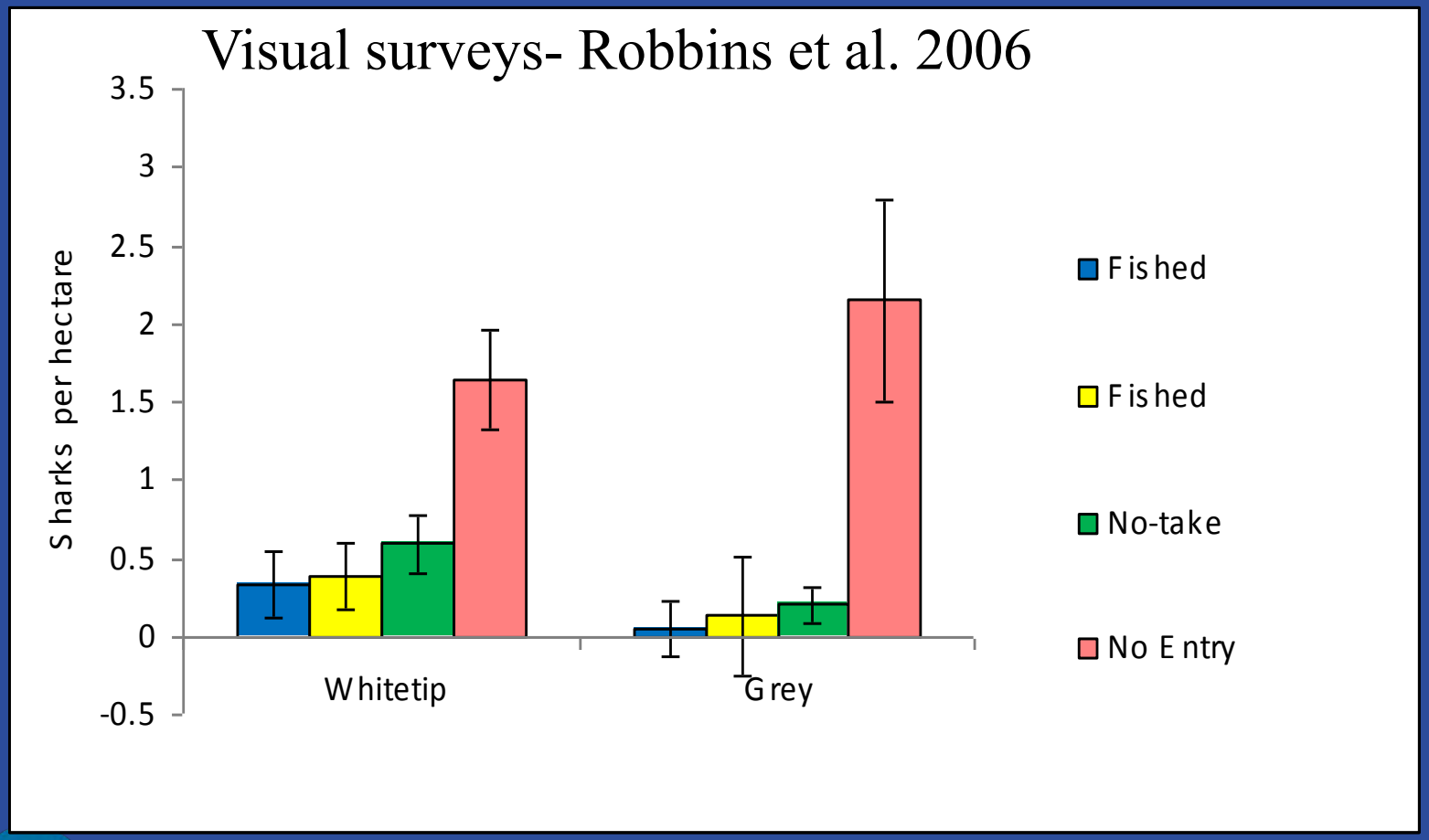


Outcome of OTHER design principles

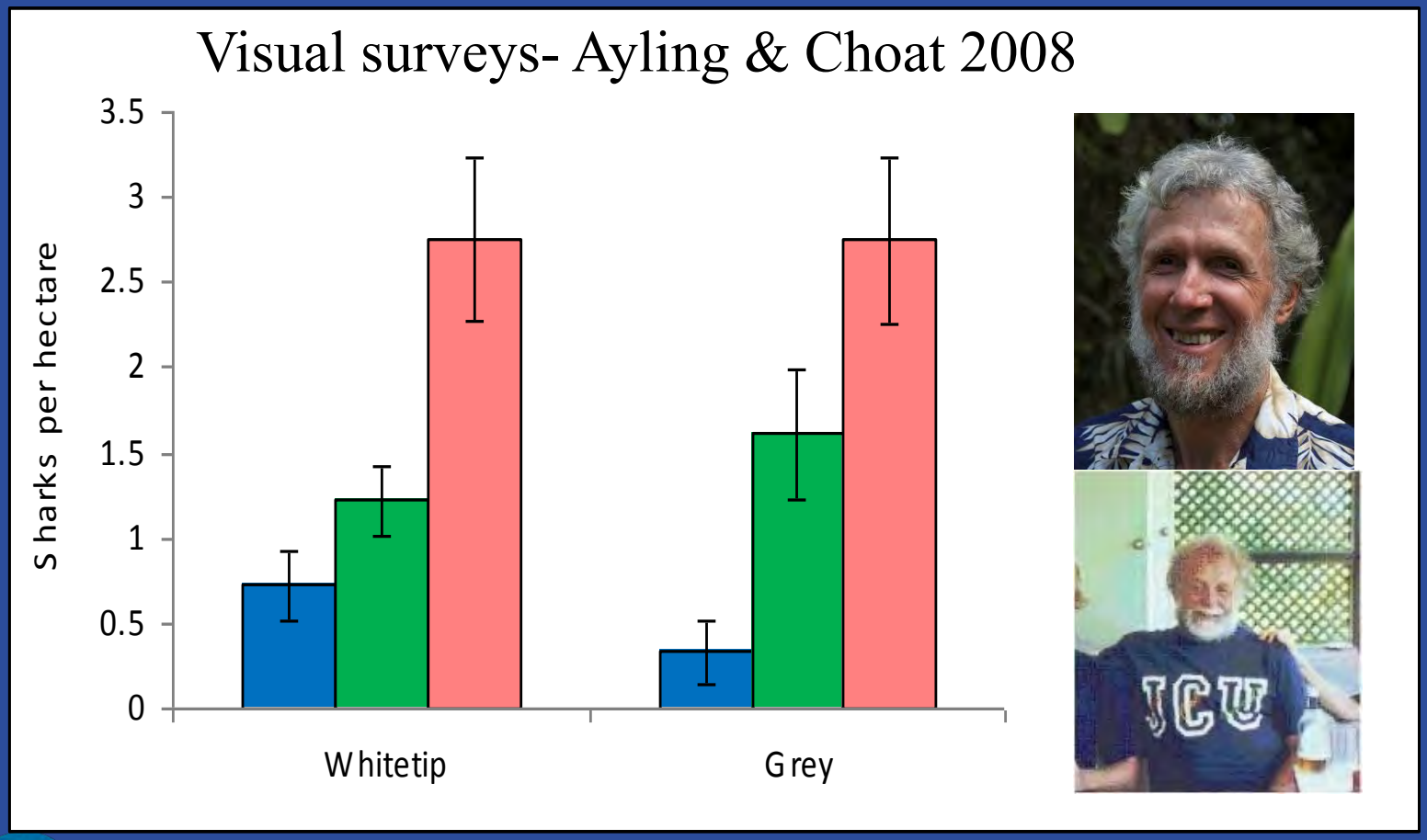
Monitoring the zoning network- Sharks



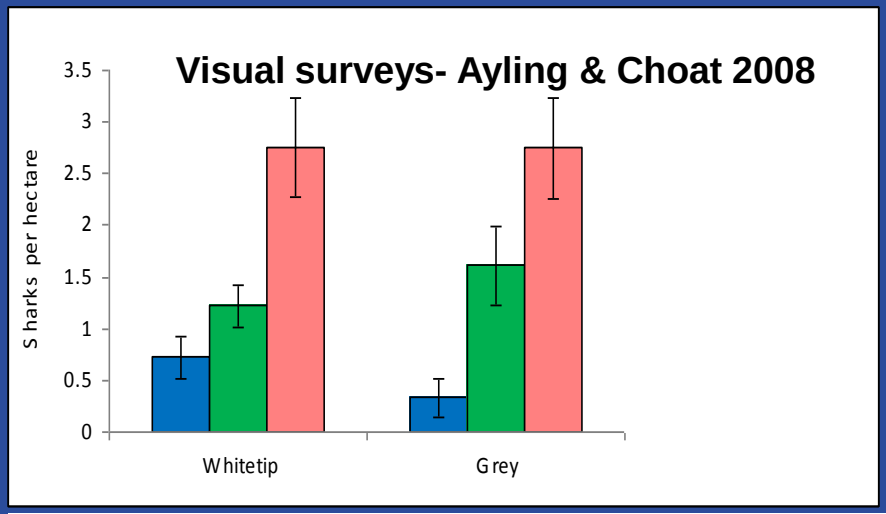
Monitoring the zoning network- Sharks

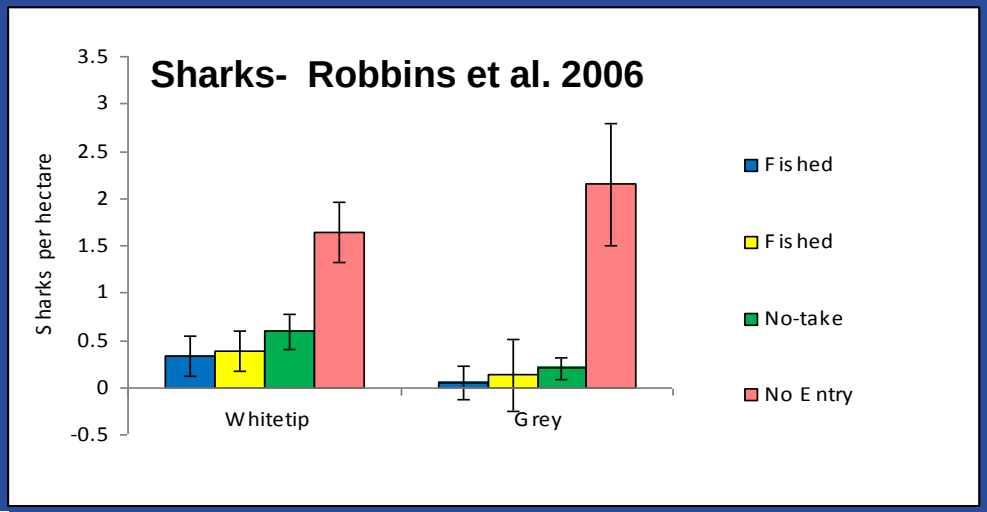


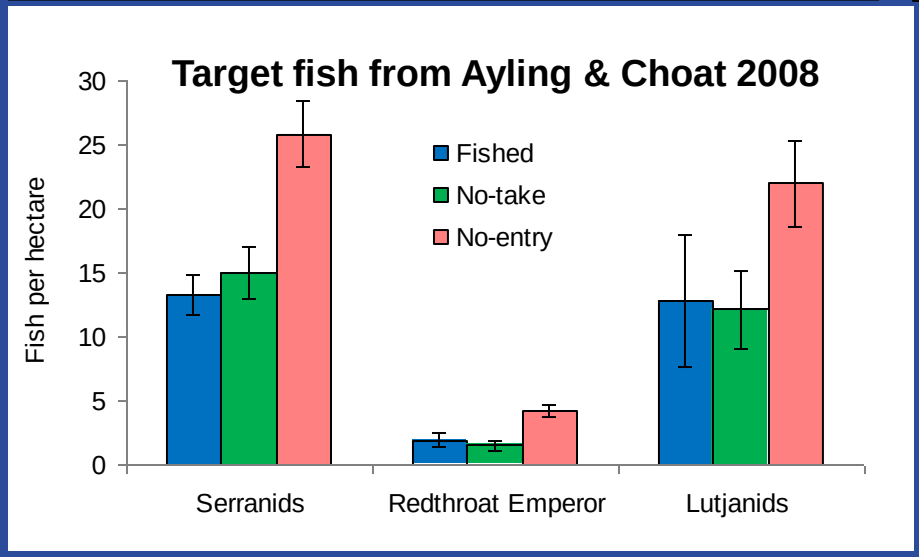
Monitoring the zoning network- Sharks



Monitoring - No-entry zones, wide-spread depletion & compliance







- *(Pre-2004 zoning)*
- Compliance problems
- (no-entry easier to enforce)
- Shifting baseline & depleted stocks – 66% & 31% area??!!

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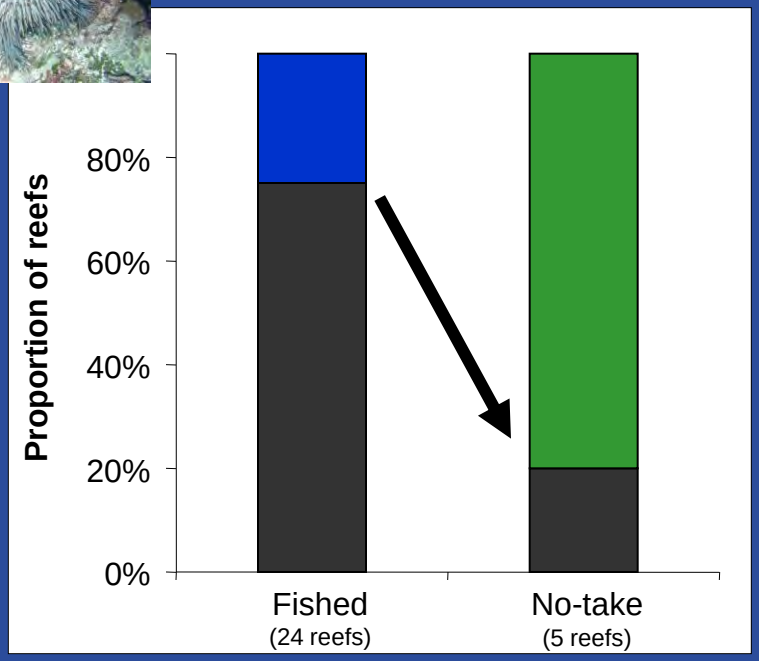
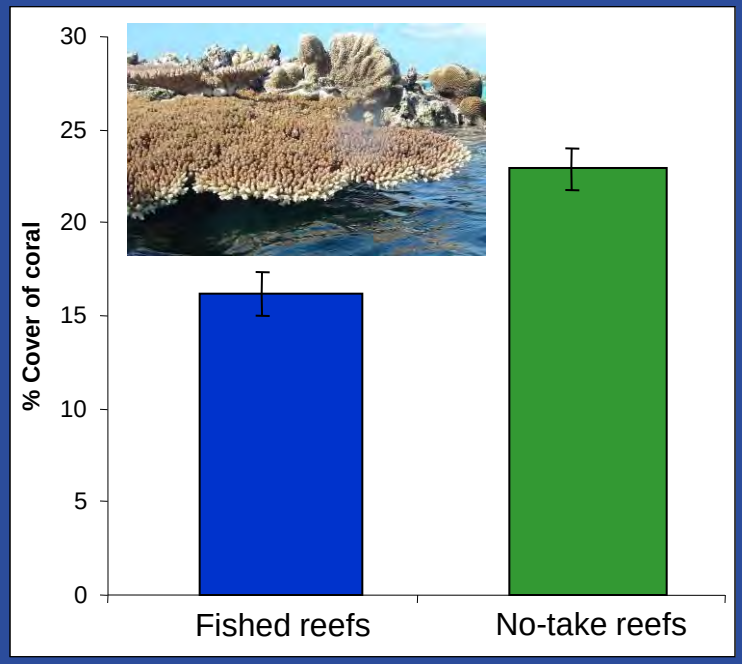
Crown-of-thorns starfish, Corals & Reef Resilience: *Indirect effects*

Proportion of reefs with COTS Outbreaks



Coral Cover



- No-take zones appear to benefit coral abundance – very basis of physical habitat & reef construction
- 1st demonstration of indirect effects not herbivory/destructive

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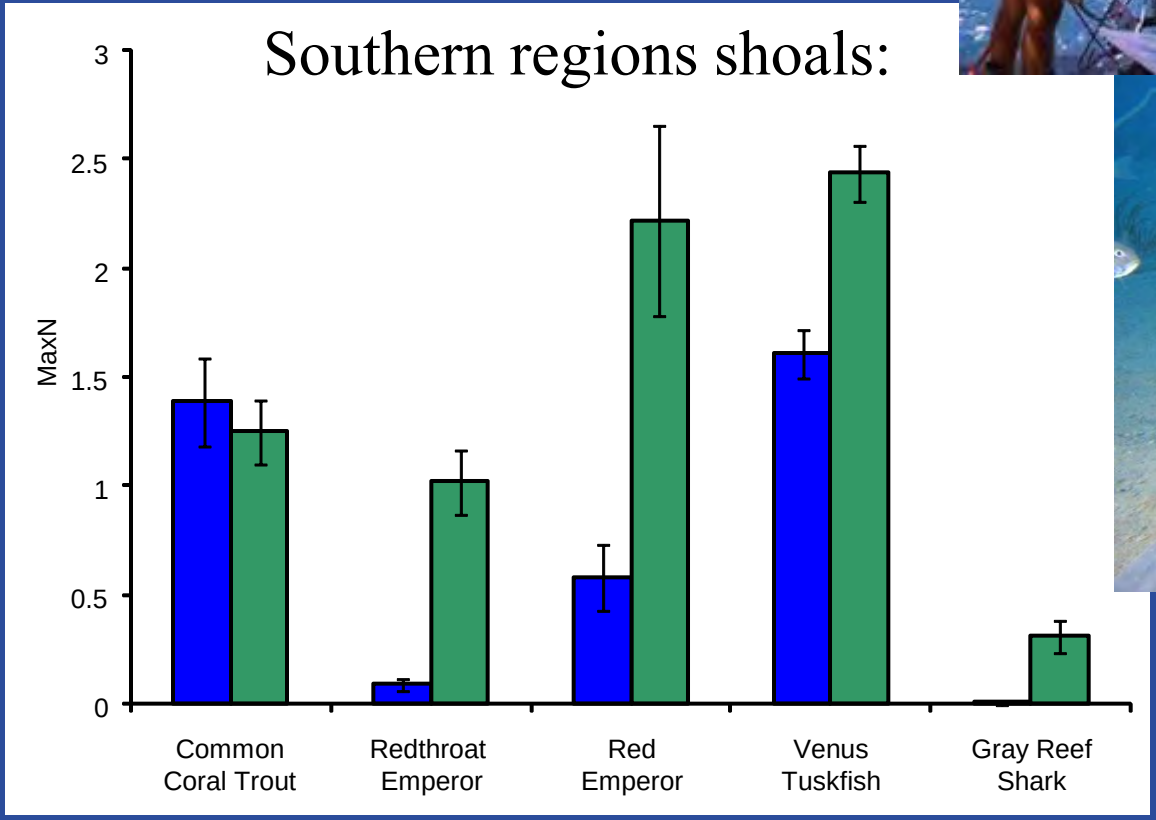
Inter-reefal shoals:



- Results vary with region, sites, spp…
- Central: more fish in open zones- confounded

Inter-reef seabed habitats: Retrospective accounting

- Lack of sufficient, detailed biodiversity knowledge for direct zoning: →
- i. Use of physical proxies; + ii. Seabed biodiversity study:
- Proportion in no-trawl zones (Pitcher et al. 2007).

Biodiversity level	Measure	Pre-2004	2004 Zoning	Average increase
850 Species	> 20% of biomass	685 / 850	850 / 850	30%
38 Species Groups	> 20% of biomass	28 / 38	38 / 38	27%
16 Species Assemblages	> 20% area	9 / 16	16 / 16	36%
9 Seabed Habitat Types	> 20% area	5 / 9	9 / 9	31%

- **Outcome** of good process- biodiversity proxies

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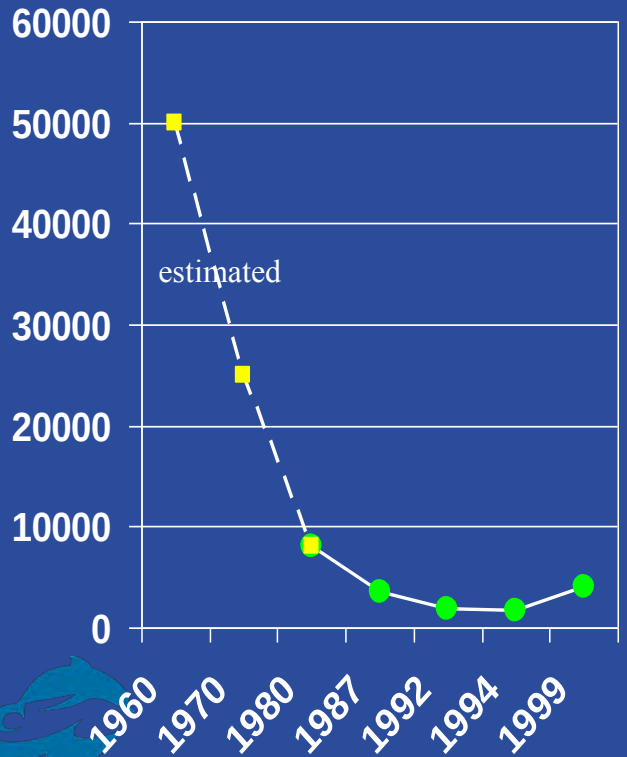
Dugong (& turtles) in the GBR

Aerial surveys since mid 1980's:



- Dugong large, mobile, low reproduction: scale
- Major decline Sthn GBR
- Dugong Protection Areas in key habitats + No-take zones
- Traditional Use agreements, gear restrictions
- Zoning beneficial
  but not sufficient
- Complementary spatial & non;
- Risk assessment approach

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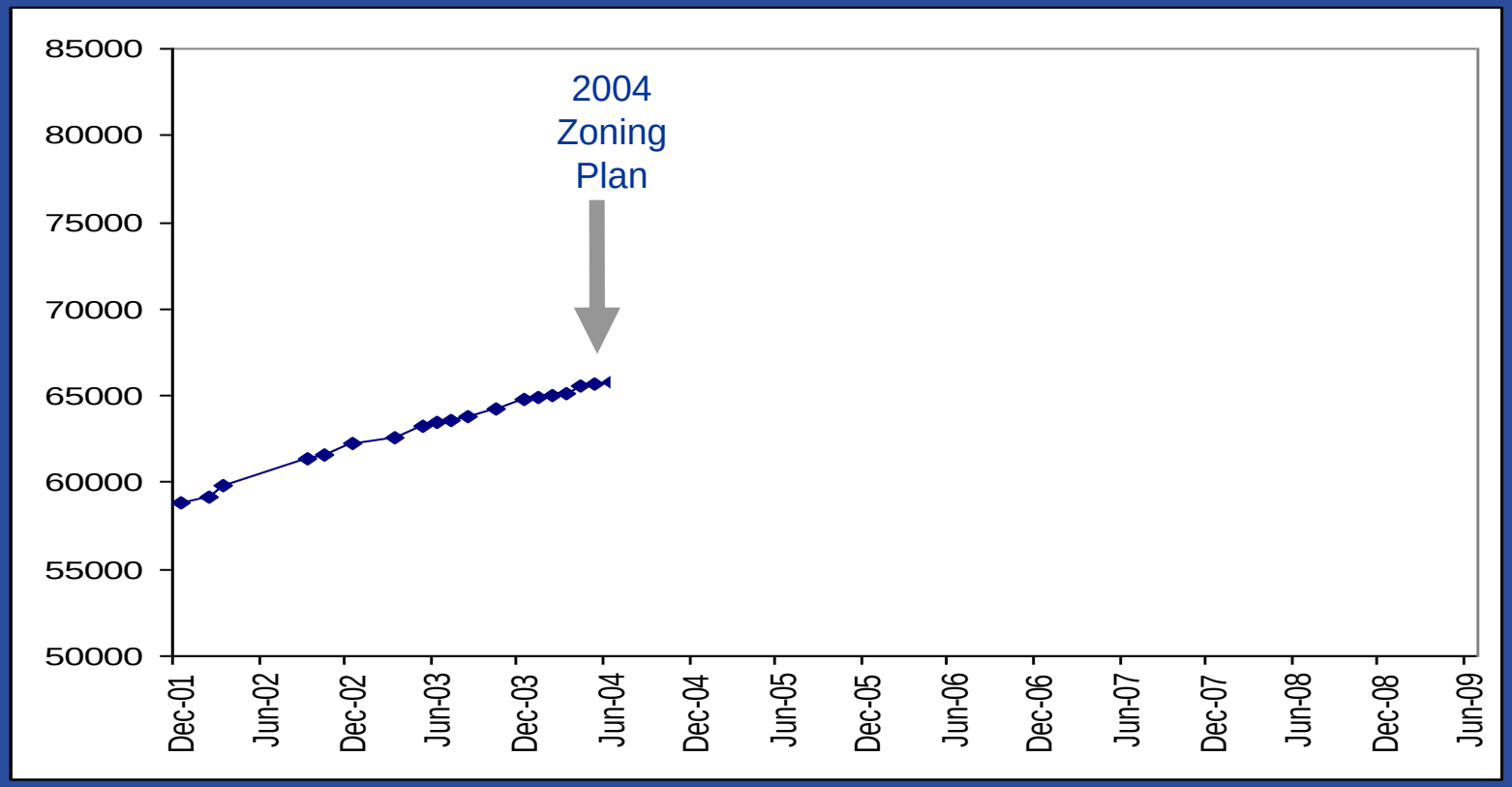
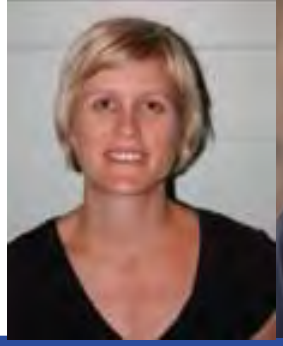
Social & economic *information:*

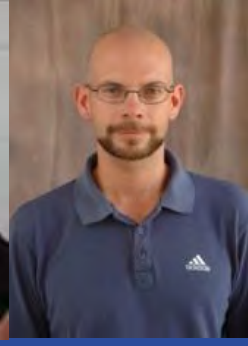
Failure of collapse in recreational fishery

Recreational vessel registrations:



Social effects of zoning:





- 77% Qlders support no-take zones (2007) & 79% sthn Aust. capital cities " " ";

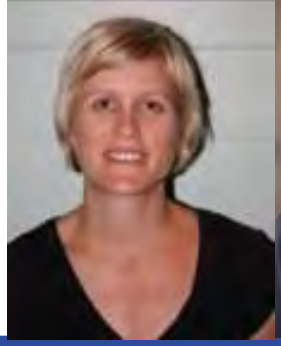
- 59% recreational fishers support the zoning; 18% charter fishing operators " " " 7% commercial fishers " " "

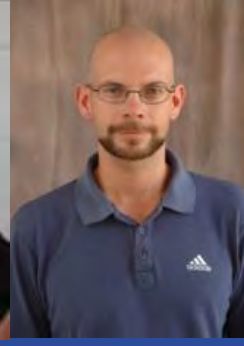
BUT

- 77%, 85% & 65% agree: protecting diversity of marine life most important goal for reef management…

- *(What about ≠ fishers…?!)*

Social effects, perceptions & engagement- a mismatch?…





Lack of support & key beliefs:	A serious mismatch:
i. Major rezoning unnecessary;	→Clear evidence previous zoning inadequate;
ii.Zoning had –ve effects on fishing businesses;	→Considerable structural adjustment $ … n x estimates
iii.Zoning has not reduced fishing impacts on GBR;	→It has (data) & not intended to manage fisheries…
iv.Fishers not adequately consulted	→Extensive & meticulous public consultation (31,500)

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Redistribution of recreational fishing effort…

CapReef:

- Only 1/9 preferred sites lost (7%);
- Catch rates dipped & recovered- size limits
- Rec fishing ~ commercial & unaffected by catch & bag limits;

De Freitas:

- Compensation further inshore (pending commercial & charter results);
- Displaced effort?

How much do no-take network subsidies balance displaced effort?

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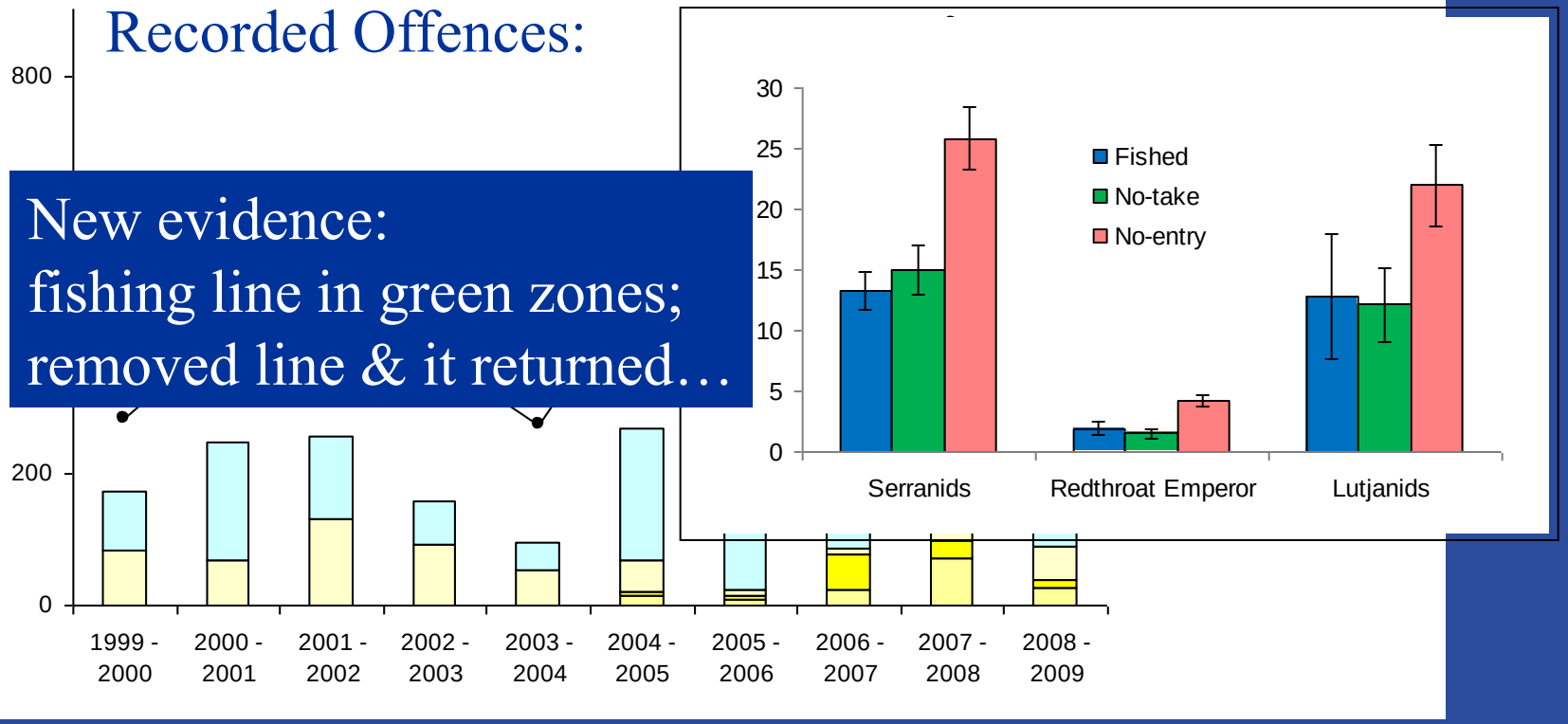
Compliance



- "There seems a strong case for increasing investment in compliance to protect such a valuable asset & revenue source…"

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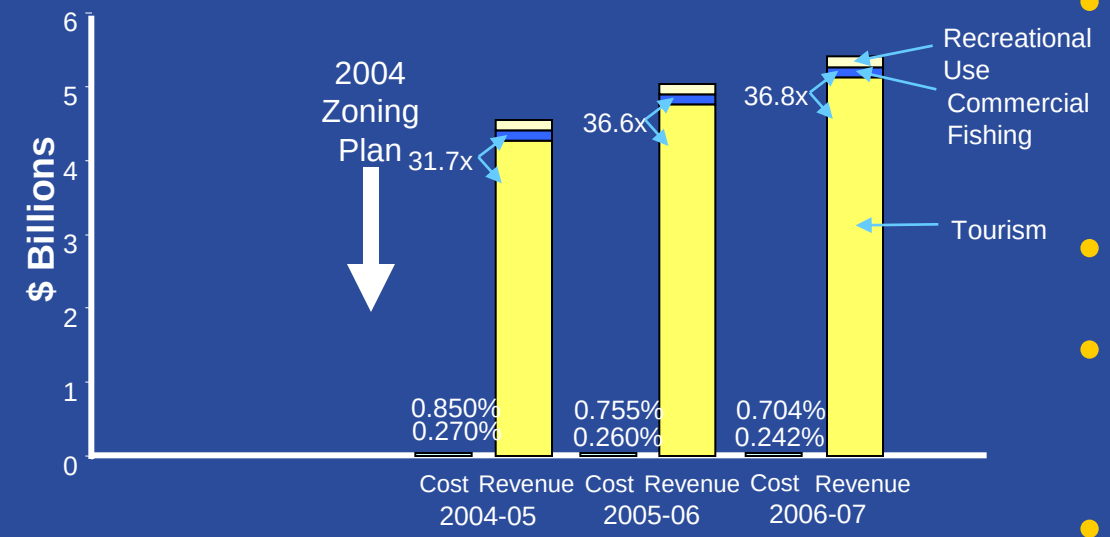
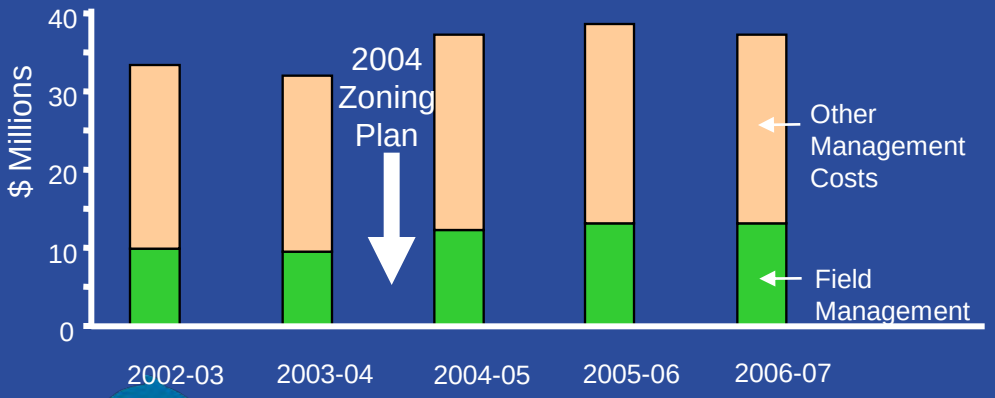
Social & economic *information* invaluable for community/political concerns.





- Income $5.5b & ~53,800 full time jobs; increasing
- Tourism = 32-36x fishing
- Enforcement expenditure <0.3% ↓
- Total GBRMPA <0.9% ↓
- Structural adjustment: $211m- ~ 3.9 % of 06-07 revenue;
- Strategic investment?
- Compliance -25%/7 fold

Take Home messages- Benefits to the GBR

- Powerful, scientifically credible consensus statement
- GBR Marine reserves have significant ecosystem benefits
  - Fish, sharks, **corals**, even dugong…
- Probable fisheries benefits:

  (watch this space)…
- Not enough for dugong, sharks (*need more, not less!);*
- ***Complementary*** *EBM*
- No-entry zones: compliance issues & shifted baseline;
- Social information as basis for engagement: fishers are concerned about conservation- direction…
- Marine reserves cost-effective… cf. popular commentary

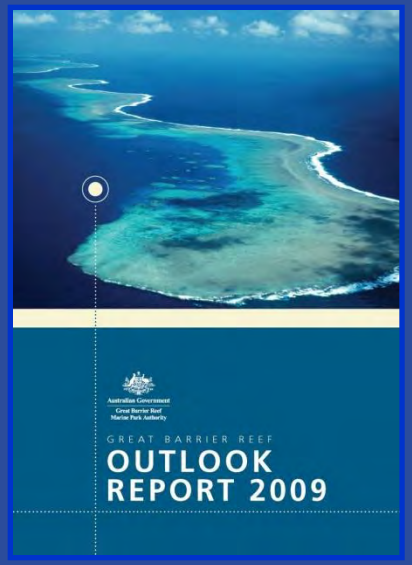
Take Homes & challenges for monitoring & science.

- Value of social & economic ***data & analyses*** *(c.f opinion)*;
- Many aspects of biodiversity ***not*** amenable to simple fished-reserve comparisons.
  E.g. Ecosystem wide biodiversity; better for ecosystem, worse for accountability…
- Many knowledge gaps; risk assessment analyses;
- Community input produces engagement - & data biases: preferred locations are different biologically...
- Baseline calibration & enforcement: no-entry zones;
- Extensive unpublished & grey literature;
- Monitoring & agency performance & scope for adaptation

Take Home messages- Adaptive Management perspective

Science to management transfer & partnership +ve & -ve…

- Process success:
  General principles + imperfect knowledge
  → ~ good outcomes.
- GBR Monitoring ↔ Management:
  Good, room for improvement
- Outlook Report..



- Documenting decline of reefs?

Adaptive Management & monitoring

"structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring." (*learning from doing…)*

Adapt & Revise Actions & Monitoring

Plan actions *& Monitoring*

Implement Actions *& Monitoring*

Capture & Share Le

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"Active" vs "Passive" adaptive management- ELF

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Zoning history & adaptive management:

Date	Management	Monitoring
1975	GBRMP & GBRMPA created;	Australian Institute of Marine Science (AIMS);
→1988	Implementation of initial zoning schemes;	
1980, 1990s		Range of surveys of biodiversity distributions, espec. corals & fish;
1986		Crown-of-thorns starfish surveys begun (AIMS);
1993/4	25 Yr Strategic Plan- "*Representative Biological Communities*"	AIMS GBR Long Term Monitoring Program begun;
1990s-early 2000s		Effects of trawling study; Effects of line fishing study; Monitoring of inshore fish;
1998	Representative Areas Program for new zoning commenced;	
2003-2006		GBR Seabed Biodiversity surveys;
2004	New Zoning Plan implemented; Education & surveillance/ enforcement programs;	Initial monitoring;
2006-2008		Post-zoning monitoring;
2009	GBR Outlook Report 2009 → Parliament.	
2010	This review	