Effects of trawling on sessile megafauna in the GBR & evaluation of the efficacy of management strategies

Roland Pitcher, Nick Ellis, Bill Venables, Ted Wassenberg, Charis Burridge, Francis Pantus, Greg Smith, Mat Browne, Peter Doherty, John Hooper, Neil Gribble, Ian Poiner plus many others from CSIRO and other agencies

CRC Reef Research Centre

Great Barrier Reef Marine Park Authority

Fisheries Research & Development Corporation

National Oceans Office

CSIRO

Queensland Government Department of Primary Industries

museum

Australian Institute of Marine Science

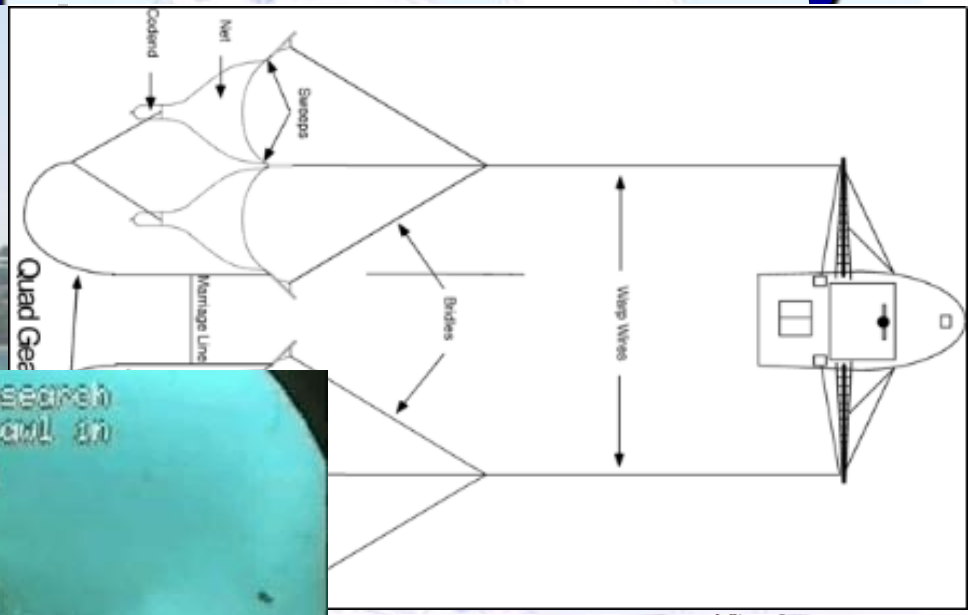
Queensland Government Department of Primary Industries

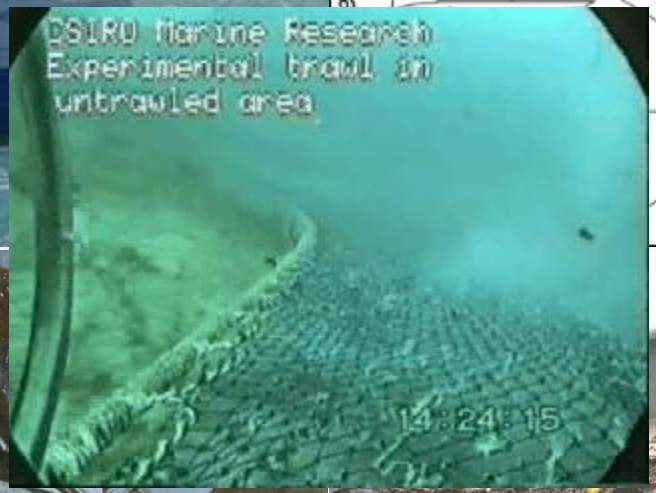
Catching Fish for Everyone! QSIA Queensland Seafood Industry Association Ltd

About the Qld EC prawn trawl fishery

Numbers of boats:

max >1400 in 1979
max effort in 1997, 840 boats
now ~300 boats





Zoning in the Great Barrier Reef MP

A series of related projects: components in assessment

- Effects of Trawling – impacts
- Trawl fleet – effort dynamics
- Seabed recovery
- Mapping distributions of species and habitats
- Modelling: integrate & evaluate trawl management

... risk assessments and other applications

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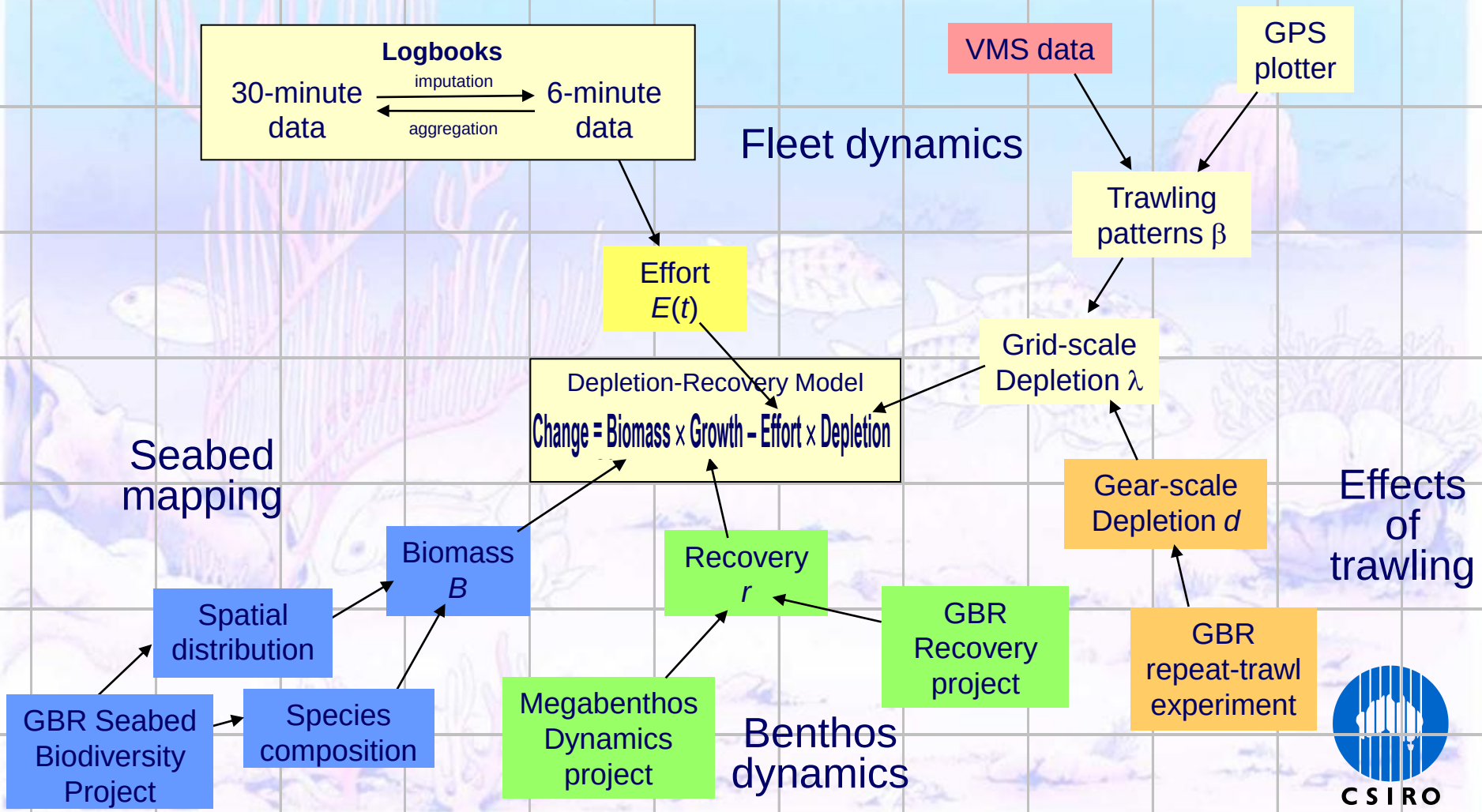
Trawl Scenario Model for MSE

- Provides a framework for integrating & synthesizing empirical research



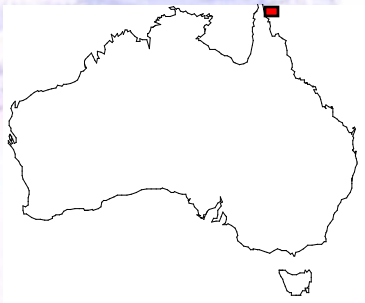
EoT: series of sub-projects, 1991-1996

- Initial descriptive sampling — facilitated design
- Bycatch composition & fate of discards (seabirds)
- **Effects on seabed habitats & assemblages:**

8000 km² Spatial 80 km² scale 0.8 km²

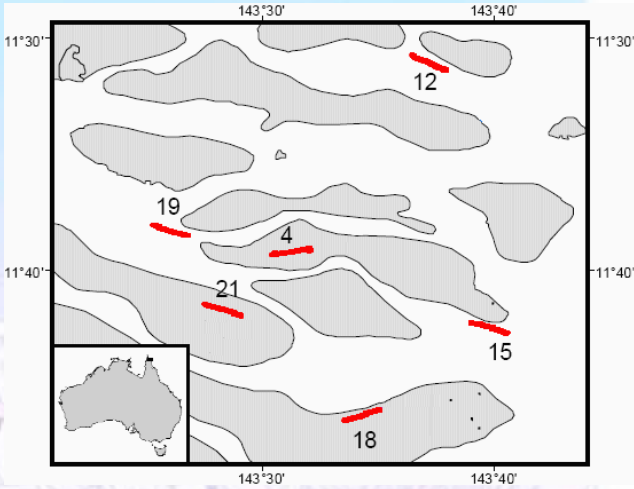
  - Closed vs Open area comparison
  - Before-After-Control-Impact experiment (1x trawl / area)
  - **Repeat trawling depletion experiment (13 trawls / area)**

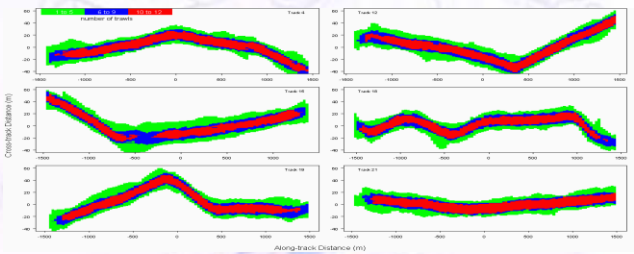
- Large scale implications of the results



Depletion Experiment

- Determine what intensity of trawling would cause substantial impact on sessile benthos
- Quantify the rate of impact of successive trawls on seabed benthos
- 13 repeated trawls were conducted on six, 2.7 km long tracks (~0.8 km²)
- Information about "before" status of benthos





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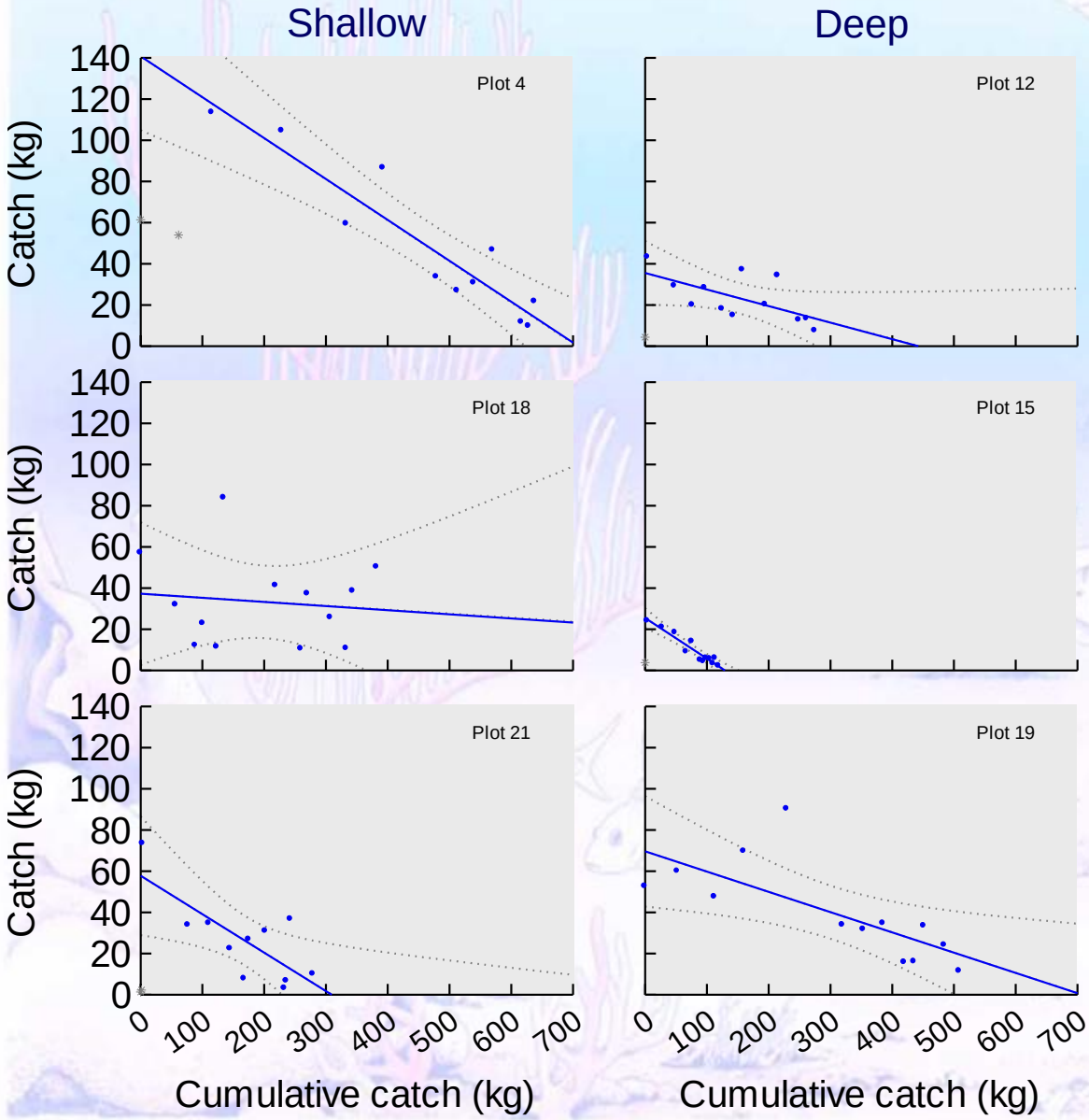
Depletion Experiment — summary results



- Each trawl removed 5–20% of benthos
- 13 trawls removed 70–90% of benthos
- Impact rates differed among biota

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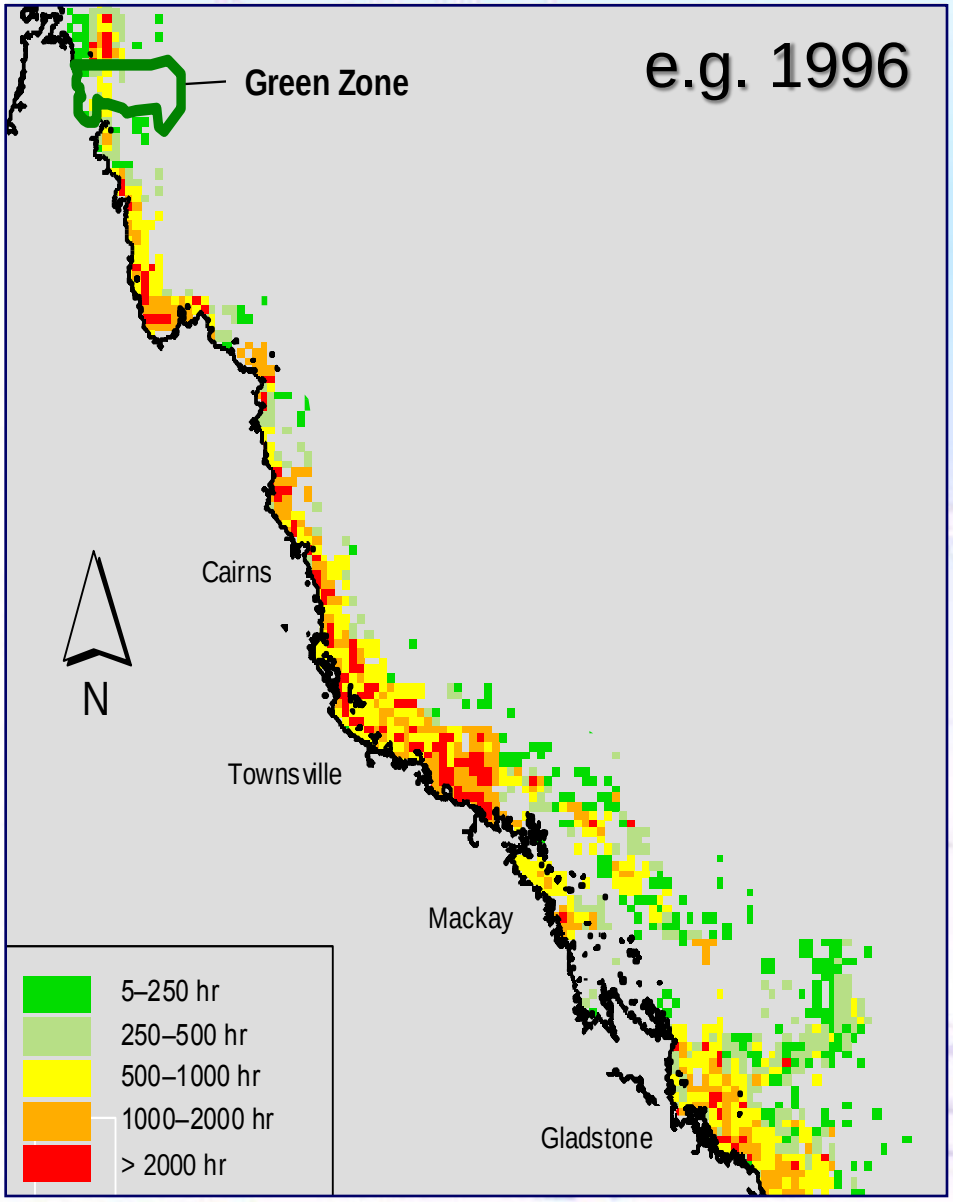
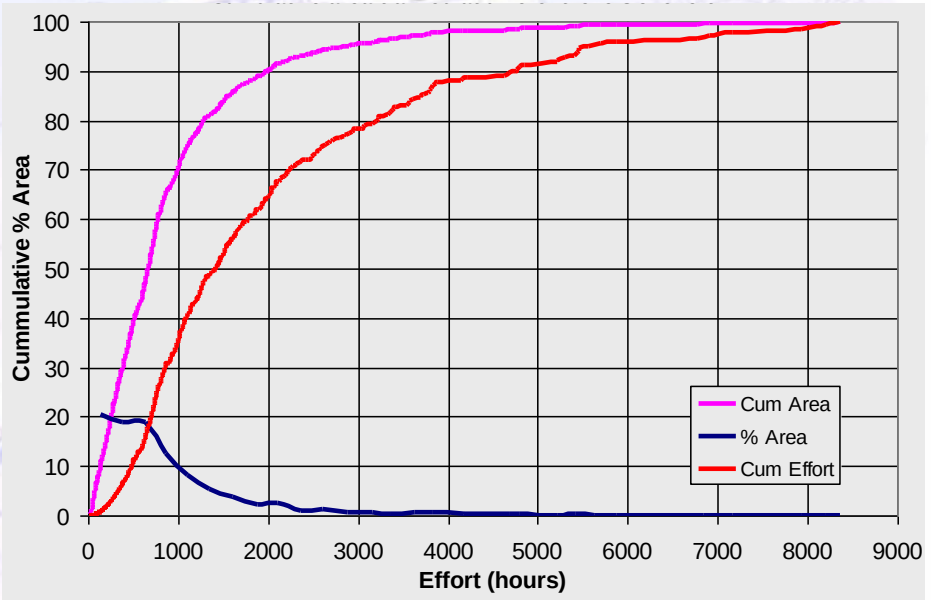
Trawl effort distribution patterns

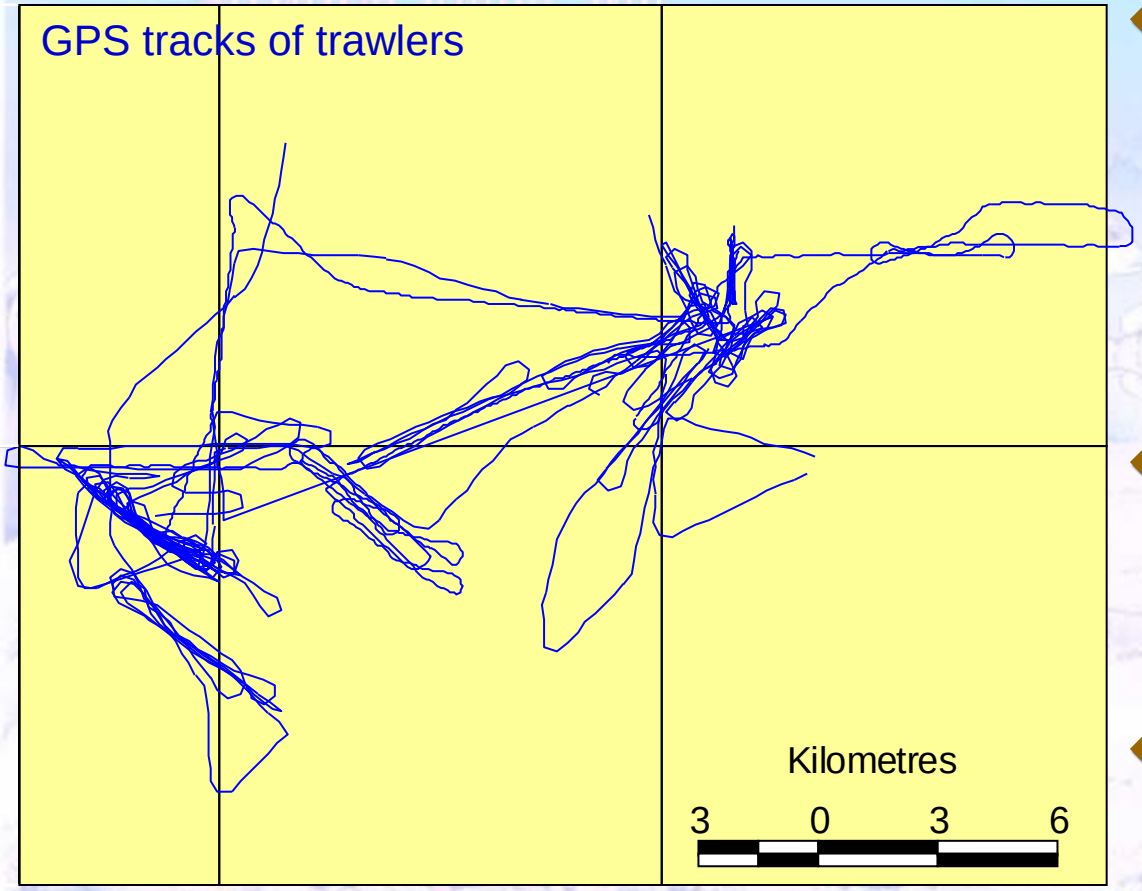


- 70% of 0.10° grids had recorded effort
- 50% of effort aggregated in <20% of grids
- 70% of grids <1,000 hrs ≈ 1x coverage, if uniform



Distribution of effort within grid cells

- Trawl effort also aggregated at fine spatial scales
  - Even in grids with >1000 hrs, ~½ the area is not trawled



- Conversely, a fraction is trawled very intensively
  - in grids with >4,000 hr (only ~2% of grids), ~5% of area trawled >13x
- Aggregated trawling removes less benthos than random or uniform
- Must consider in modelling

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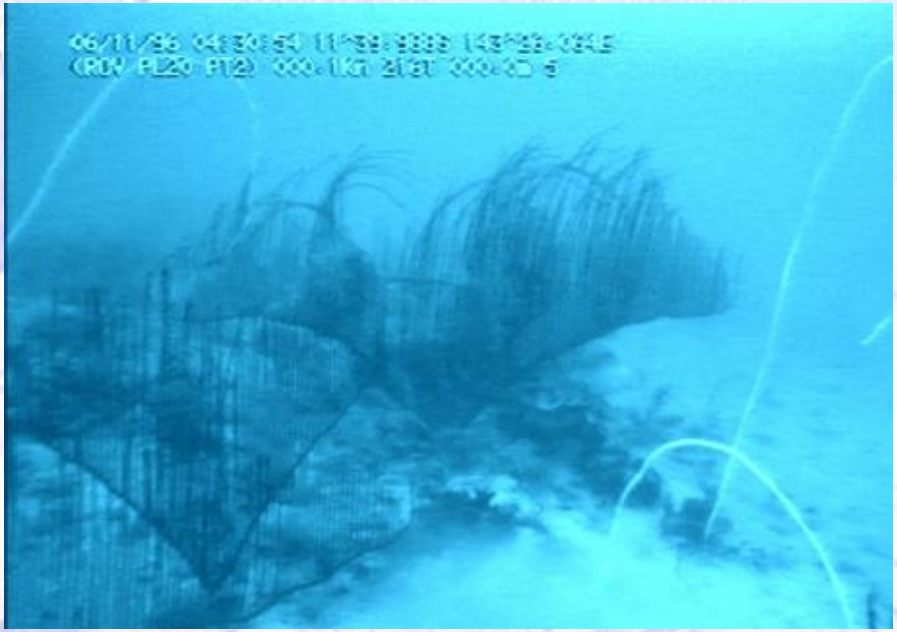
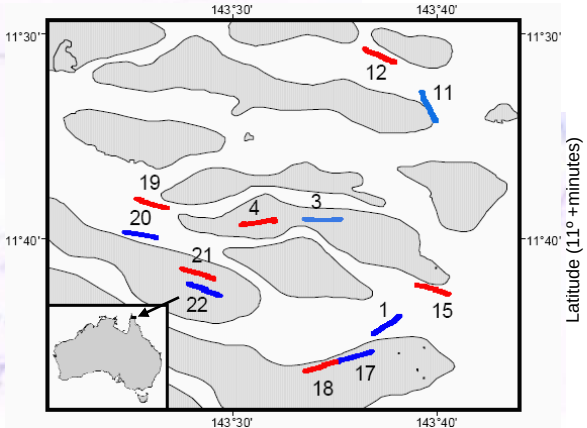
Recovery dynamics after trawling, 1996-2001

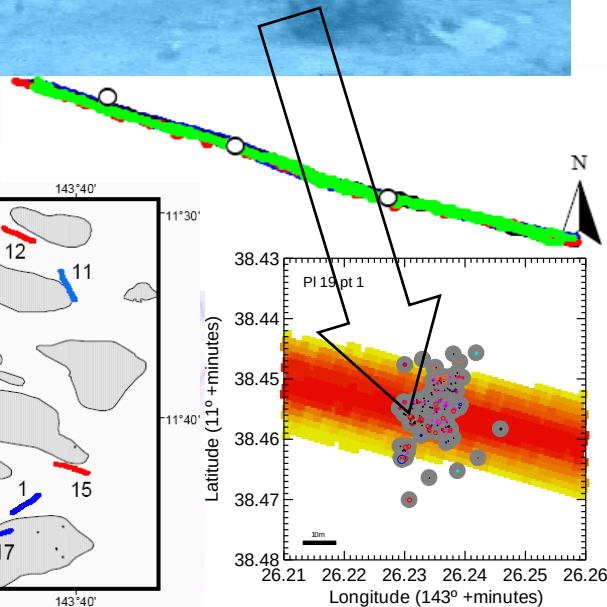
- Measured by video Sled & ROV

- Trawled

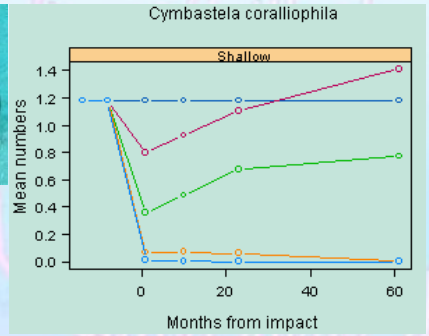
- Control

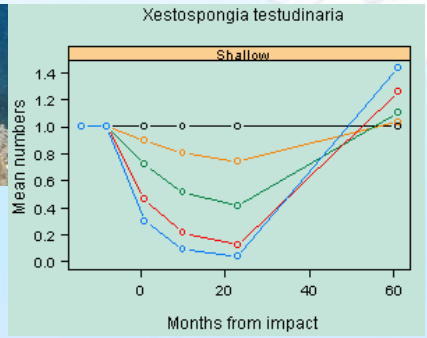


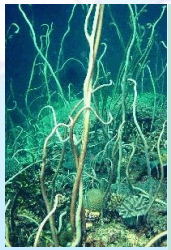


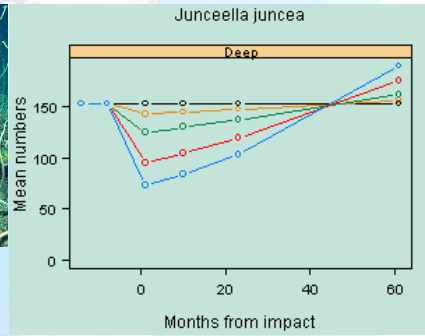


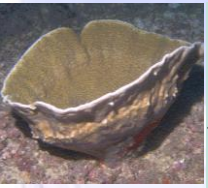
Example effects & recovery observed by sled

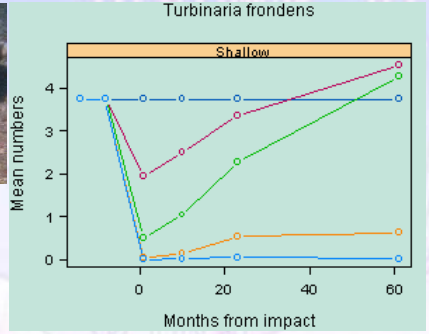


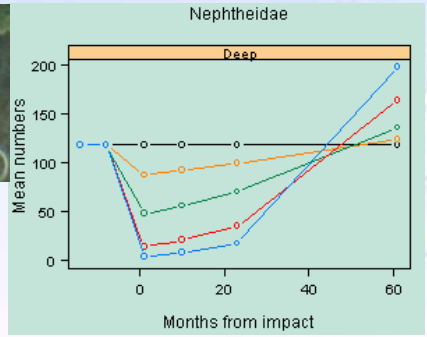


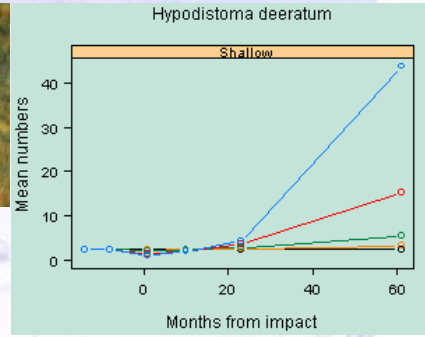


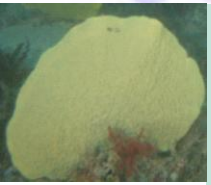


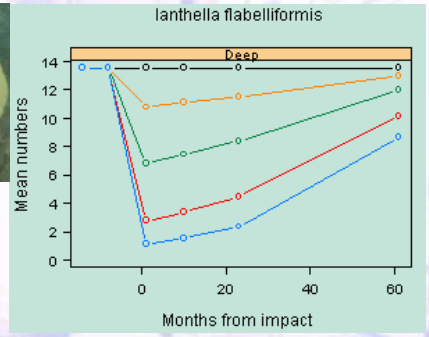


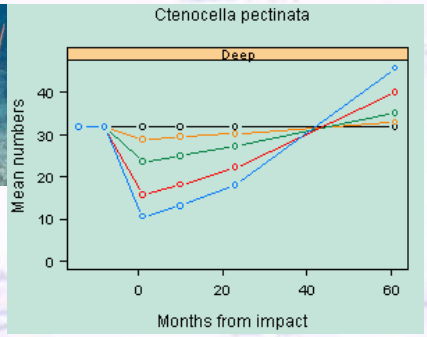


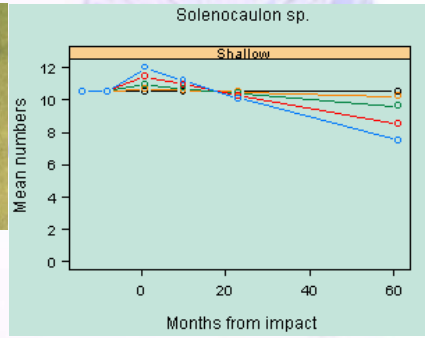












Mapping seabed biodiversity, 2003–2006

QDPI&F *FRV Gwendoline May*

AIMS *RV Lady Basten*

Prawn trawl

Towed Video

Benthic Sled

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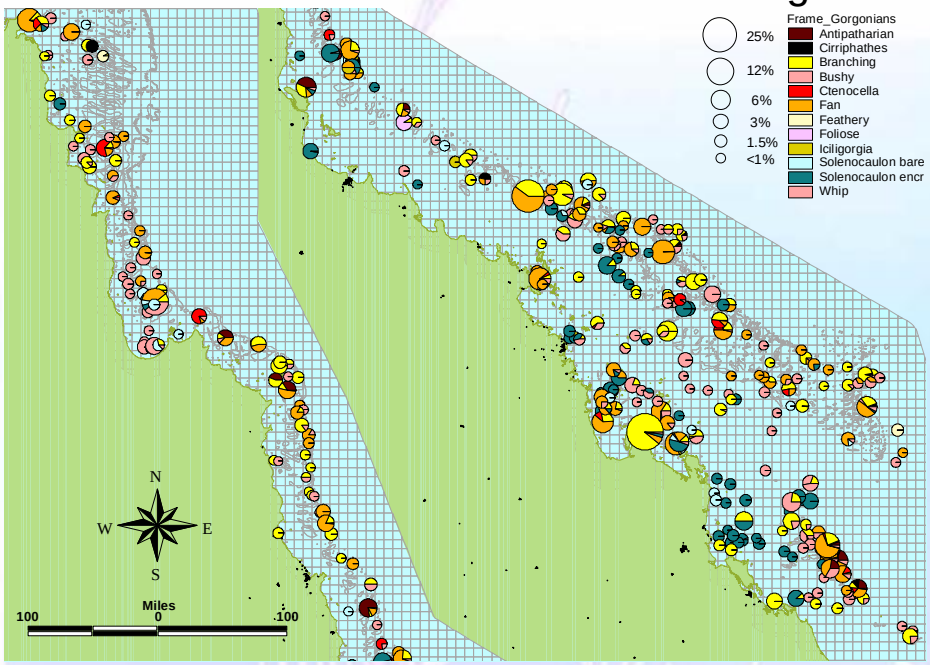
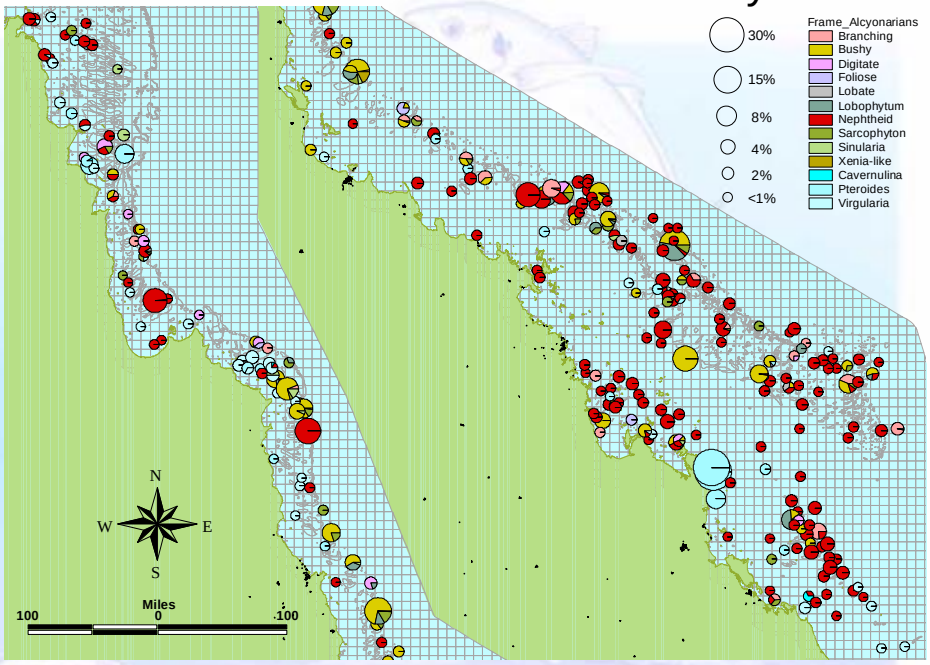
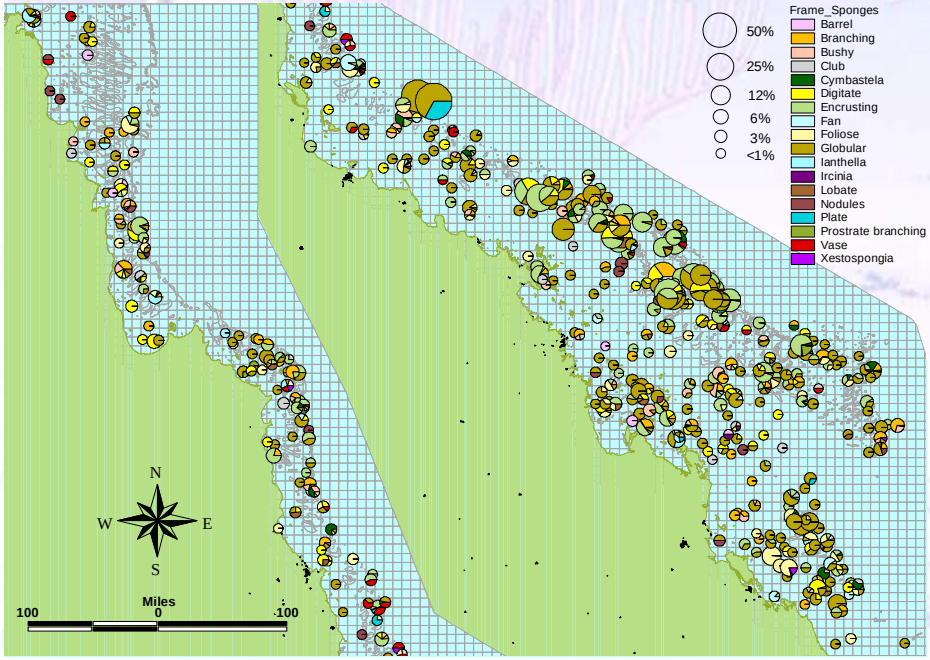
Gorgonians



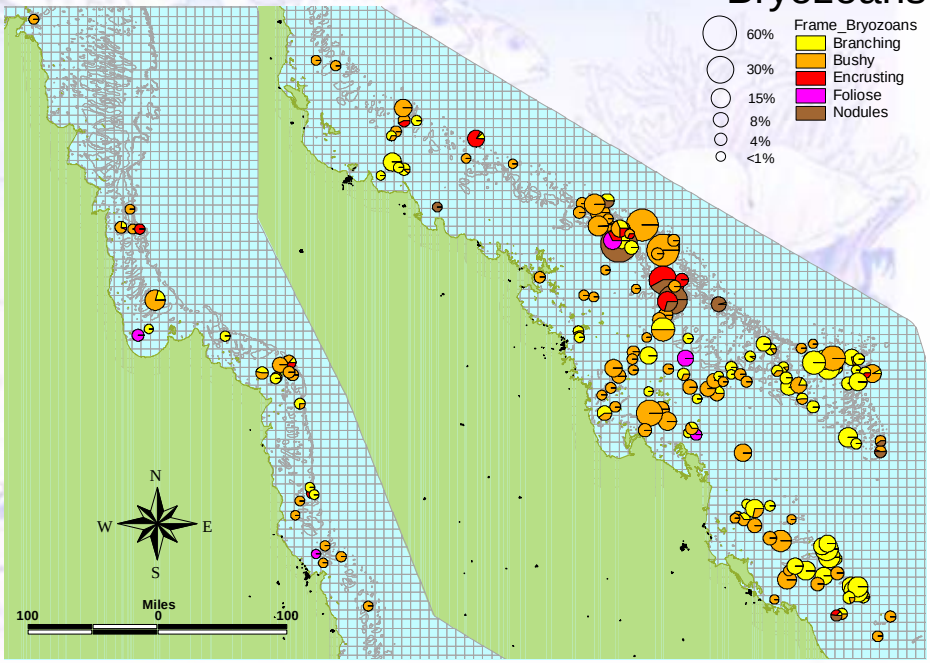
Alcyonarians



Sponges

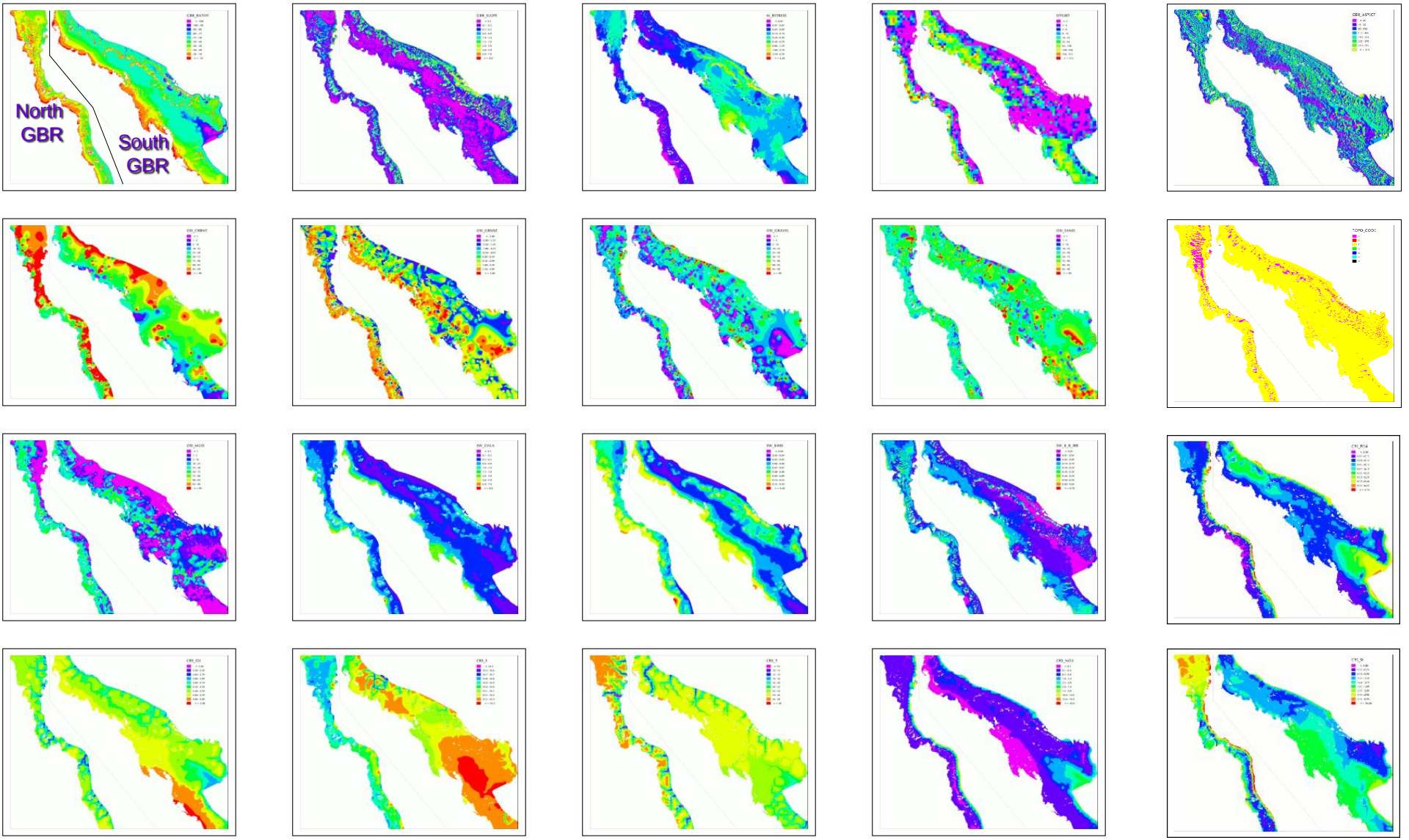


Bryozoans

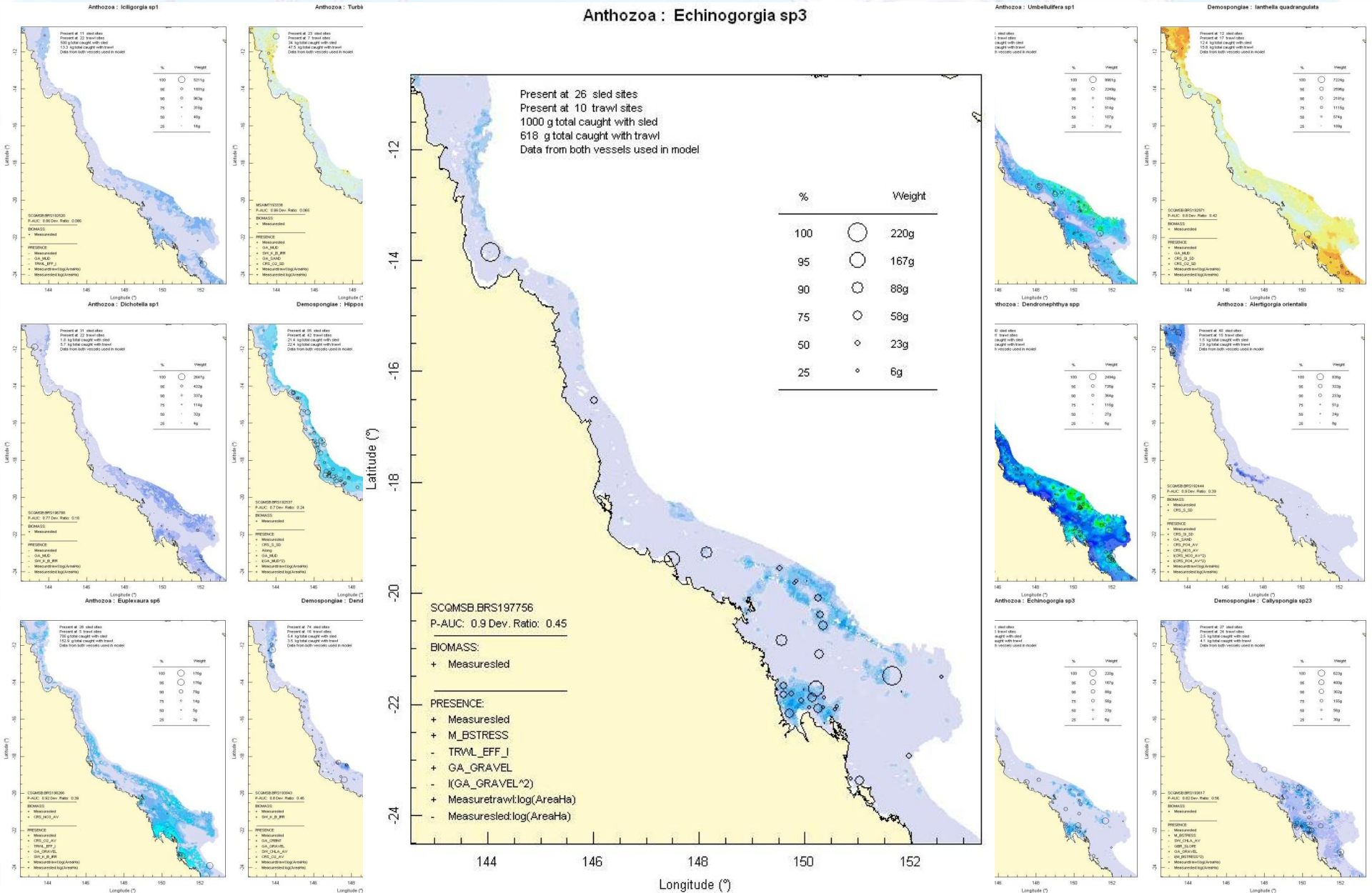


Modelled with 28 environmental variables

- eg.Bathymetry, slope, current stress, sediments, turbidity, nutrients, fishing etc



Predicted sessile benthos distribution maps



Trawl Management Scenario Model

- Synthesises & capitalises ~15 years of research

FAO data

Landings

extrapolation

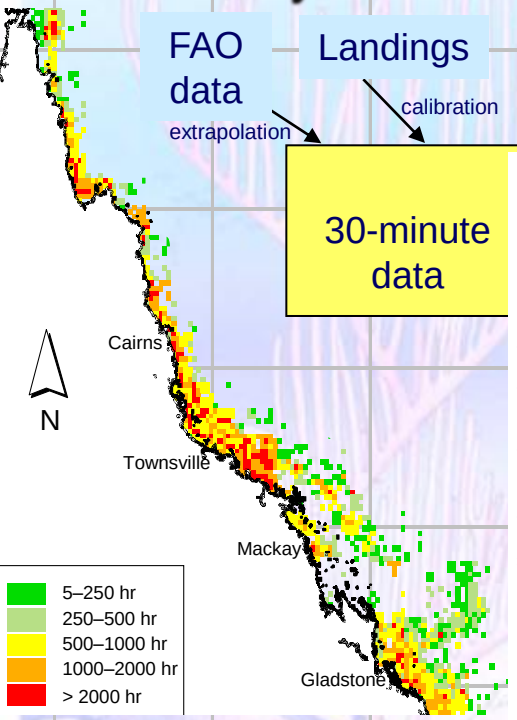
calibration

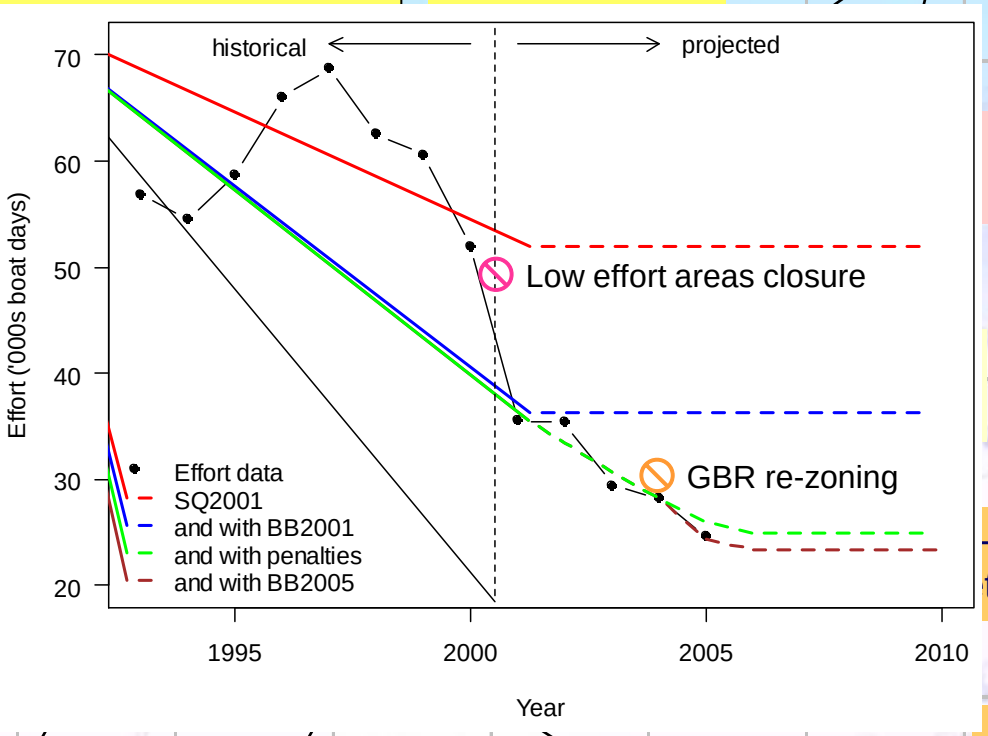
30-minute data

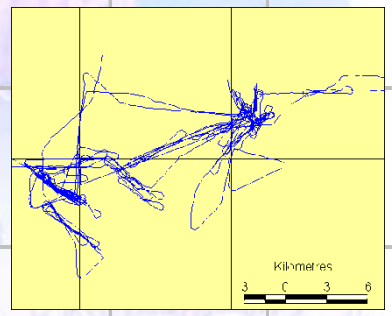
Alternative

VMS data

GPS plotter







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Spatial distribution

GBR Seabed Biodiversity Project

Species composition

Megabenthos dynamics project

GBR Recovery project

GBR repeat-trawl experiment

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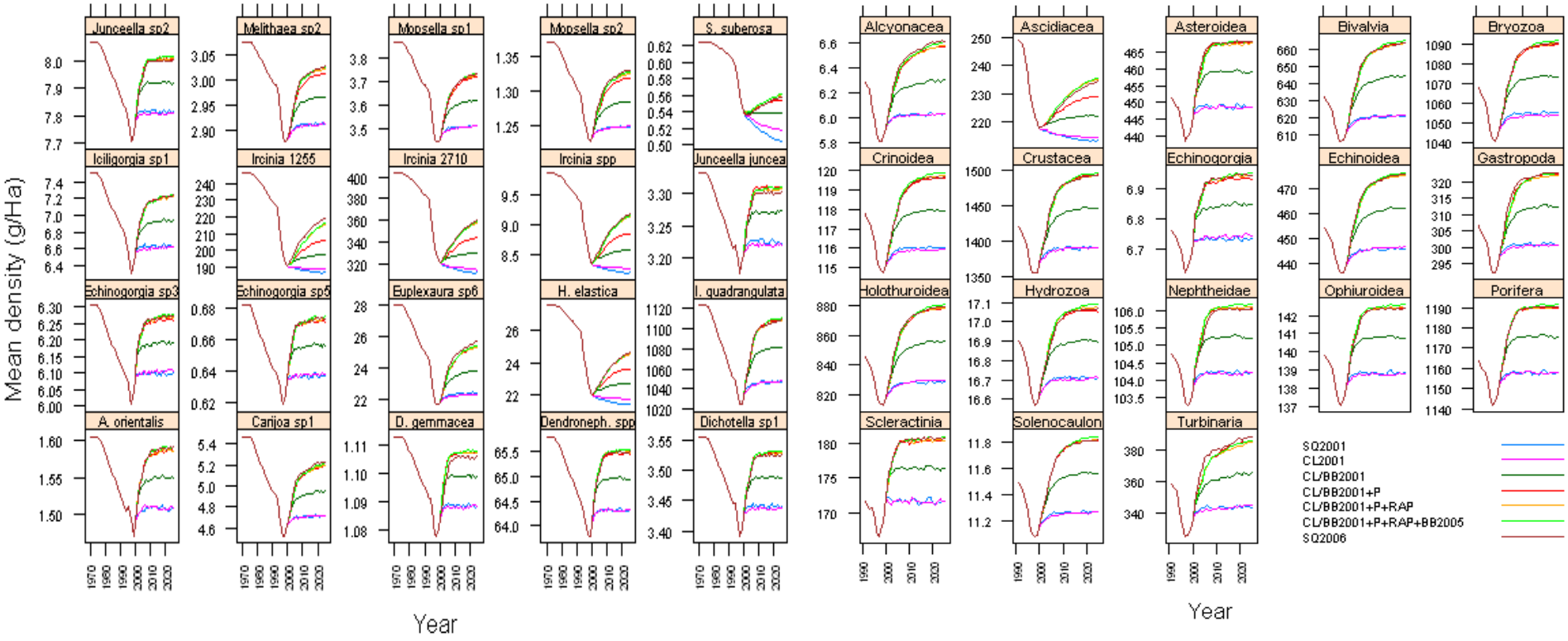
Trawl Scenario Model Predictions



Trawl Scenario Model Predictions

- Summary population status:
  - Lowest point and estimated status for 2025

Class	lowest	SQ'01	SQ'06
Ophiuroidea	95.6	96.5	98.3
Hydrozoa	95.1	95.9	98.1
Nephtheidae	93.8	95.1	97.6
Porifera	93.6	94.7	97.6
Bryozoa	92.1	93.4	96.8
Crinoidea	92.0	93.2	96.6
Asteroidea	90.7	92.5	96.5
Scleractinia	90.3	92.3	96.5
Echinoidea	89.2	90.8	95.5
Gastropoda	87.1	89.2	94.6
Holothuroidea	85.3	87.1	93.7
Bivalvia	83.6	85.7	92.9
Crustacea	83.0	85.1	92.5
Alcyonacea	79.7	82.3	89.4
Ascidiacea	71.8	70.3	77.3

Species/Genus	lowest	SQ'01	SQ'06
Dendronephthya spp	95.8	96.6	98.4
Dichotella gemmacea	95.8	96.7	98.3
Junceella sp2	94.0	95.3	97.6
Dichotella sp1	93.8	95.1	97.5
Junceella juncea	93.6	94.9	97.3
Echinogorgia sp3	93.3	94.8	97.5
Melithaea sp2	90.6	91.7	95.2
Echinogorgia	89.8	91.9	96.0
Solenocaulon	89.4	90.9	95.5
Alertigorgia orientalis	88.5	90.8	95.8
Ianthella quadrangulata	87.2	89.1	94.4
Echinogorgia sp5	86.9	89.5	94.7
Mopsella sp1	83.2	84.8	90.2
Mopsella sp2	83.1	84.5	90.1
Iciligorgia sp1	78.1	82.0	89.6
Carijoa sp1	74.2	77.3	85.6
Subergorgia suberosa	74.1	69.2	76.6
Turbinaria	73.3	77.3	87.7
Ircinia spp	66.8	65.7	73.4
Euplexaura sp6	65.0	67.3	77.0
Hippospongia elastica	60.7	59.1	67.9
Ircinia 2710	59.8	58.2	67.1
Ircinia 1255	49.6	48.6	57.1

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Summary

- Assessment at fishery management scales requires:
  - Knowledge of:
    - Impact rates
    - Recovery rates
    - Spatial and temporal trawl effort
    - Distribution and abundance of habitats & species
  - Integrative modelling to:
    - Scale up empirical studies
    - Evaluate alternative management actions
- All previous unsustainable trends have been reversed
  - Effort reductions most important
  - Closing unfished areas had little immediate/direct benefit

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