Quantitative risk assessment of benthos & bycatch sustainability in a tropical shelf trawl fishery

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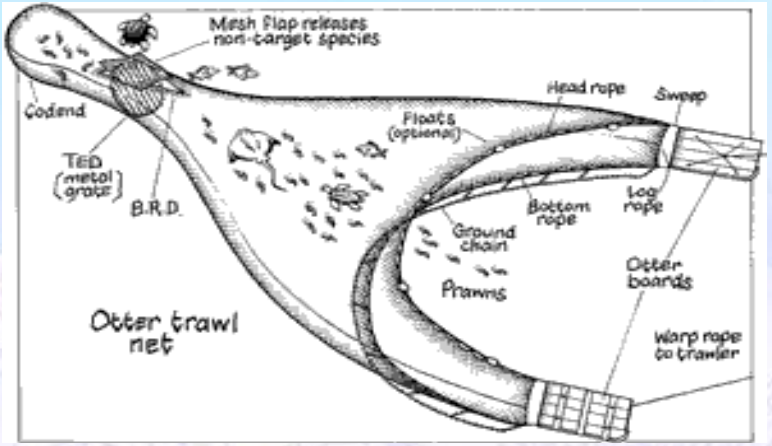
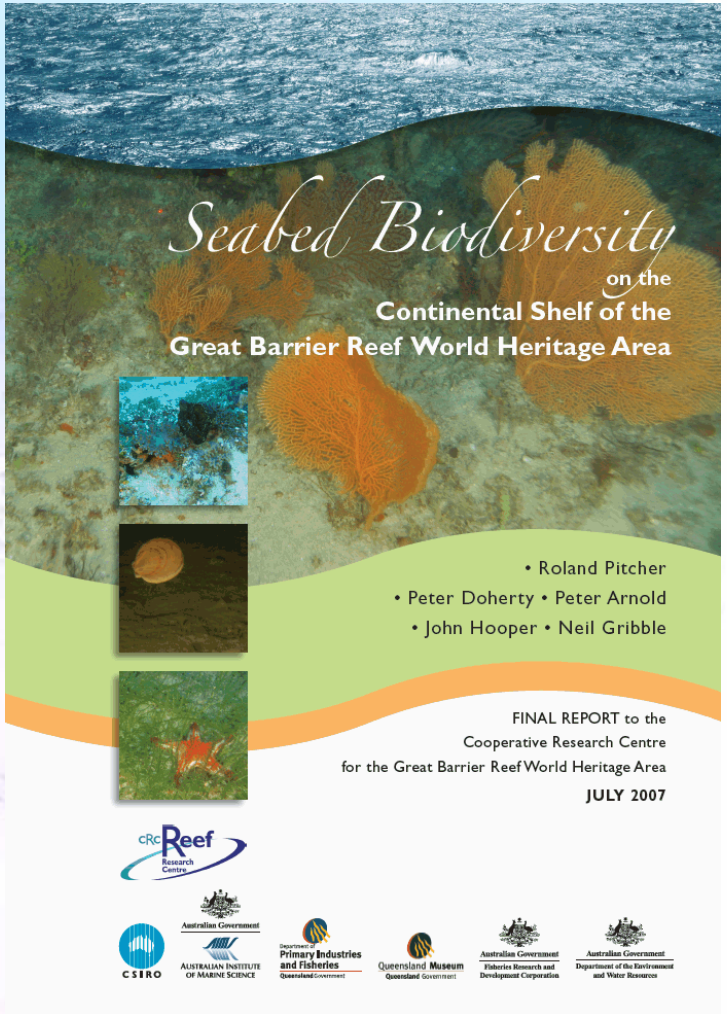
CSIRO



Builds on GBR Seabed Biodiversity Project

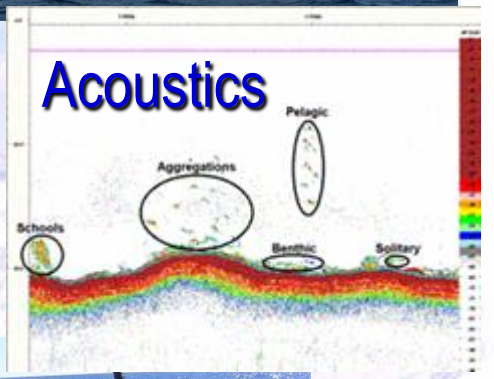
- Conservation Planning:
  - Comprehensive maps of distribution & abundance of seabed habitats & biodiversity in the GBRMP
  - Provide information to assist with –
    - assessing protection afforded by the zoning
    - developing monitoring strategies,
    - planning of future multiple-uses
- Sustainable Fisheries:
  - Assist with environmental assessments of the prawn trawl fishery
  - Development of sustainability risk indicators and reference points
  - Provide information to assist with the Trawl Management Plan



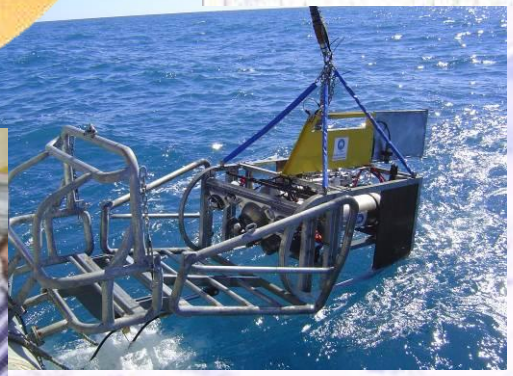
Benthic biodiversity Sampling

AIMS *RV Lady Basten*: 24 hrs, 180 days

BRUVS



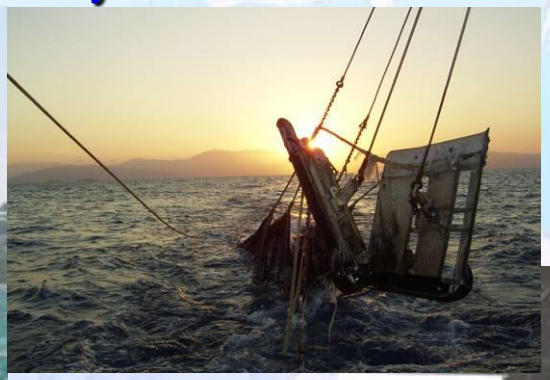
Benthic Sled



Towed Video

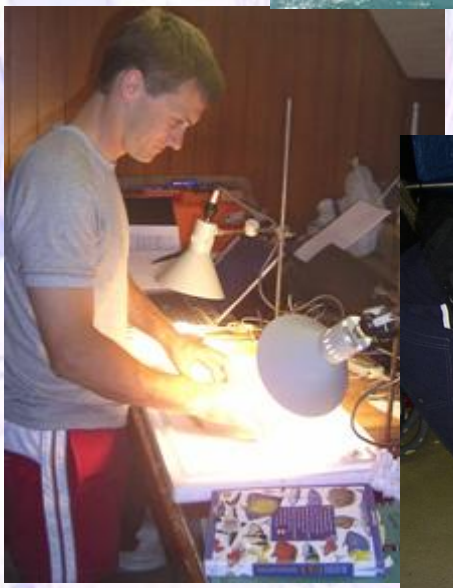
Demersal fish diversity sampling

QDPI *FRV Gwendoline May*: Night hrs, 125 days

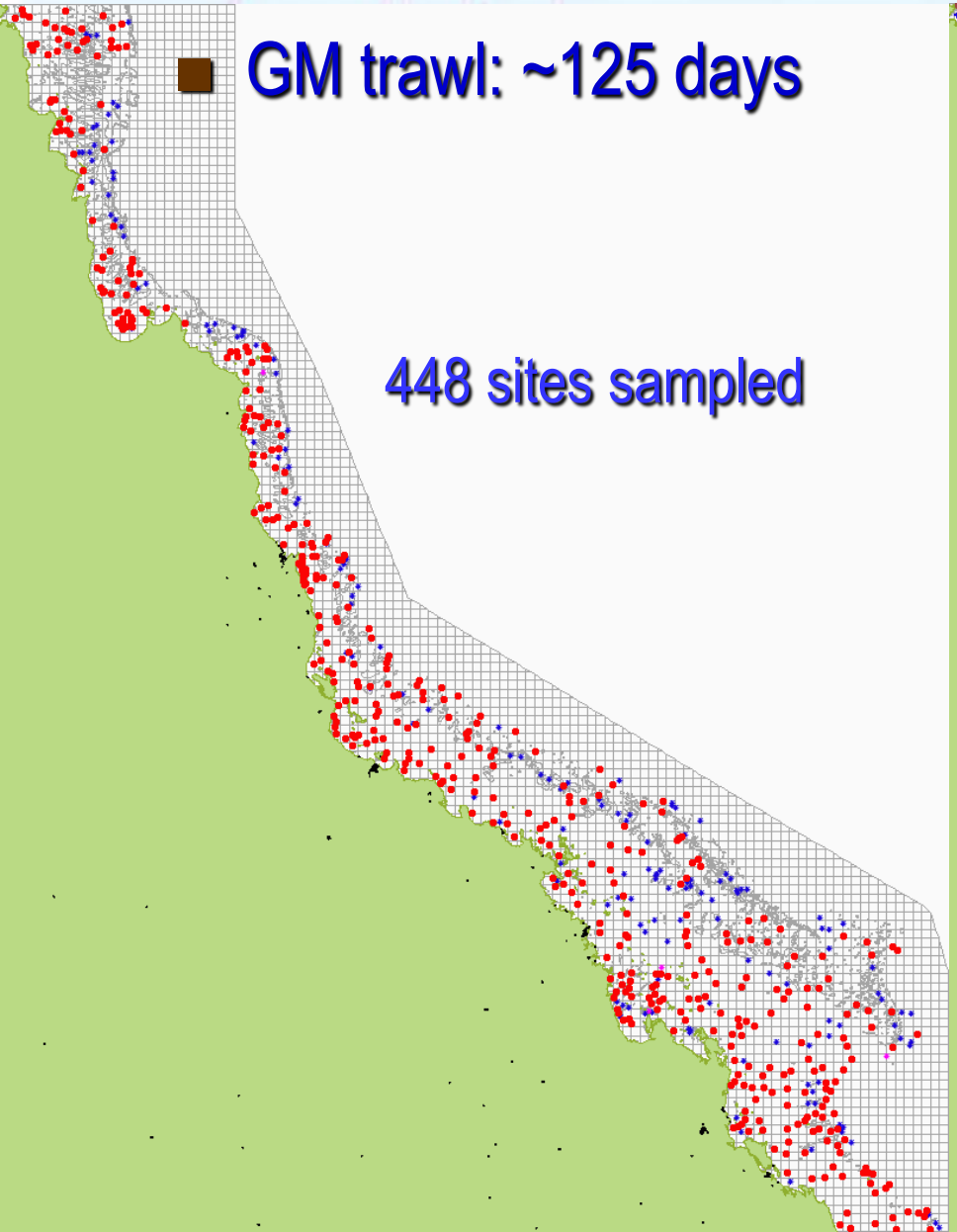


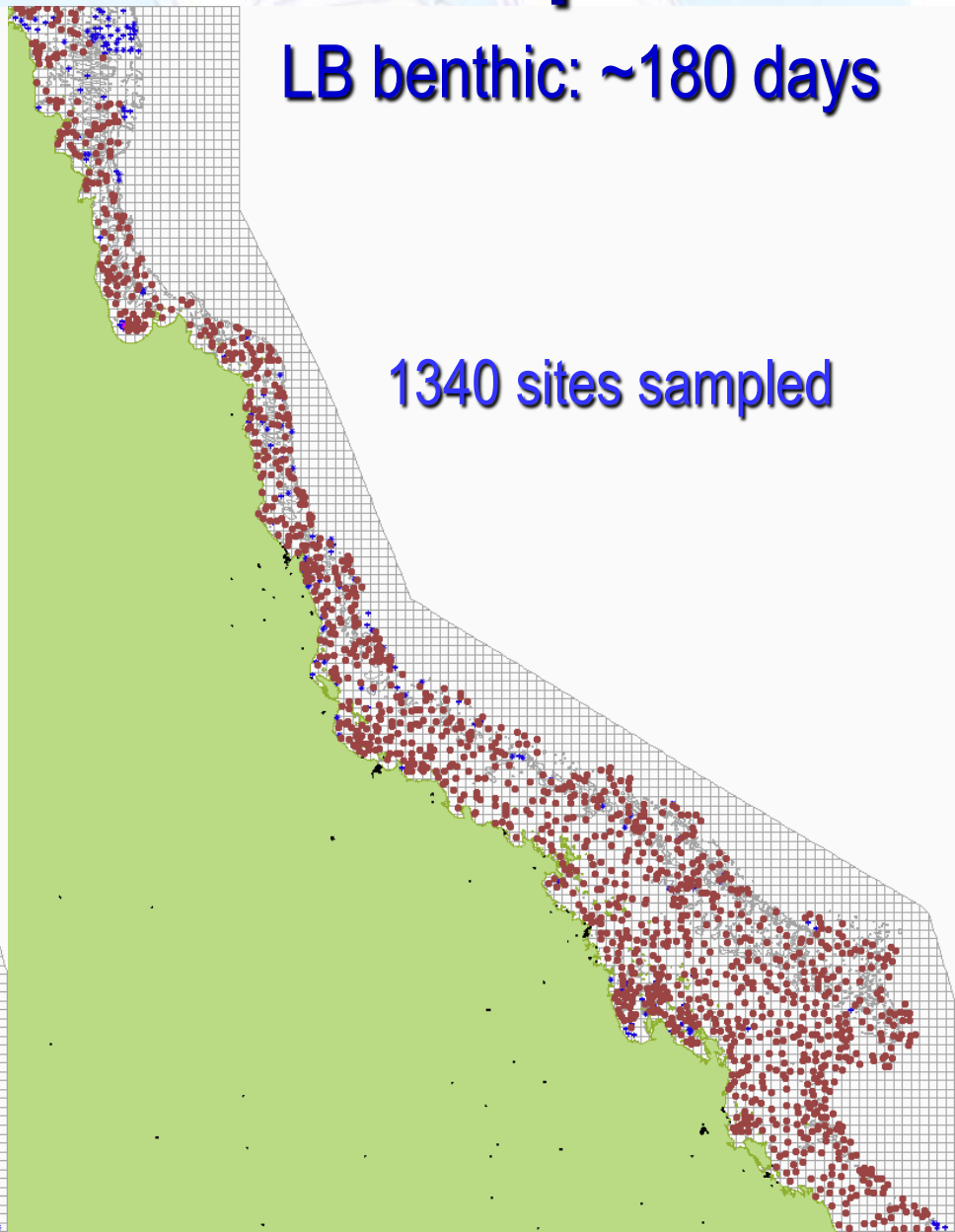
8 fathom
otter trawl

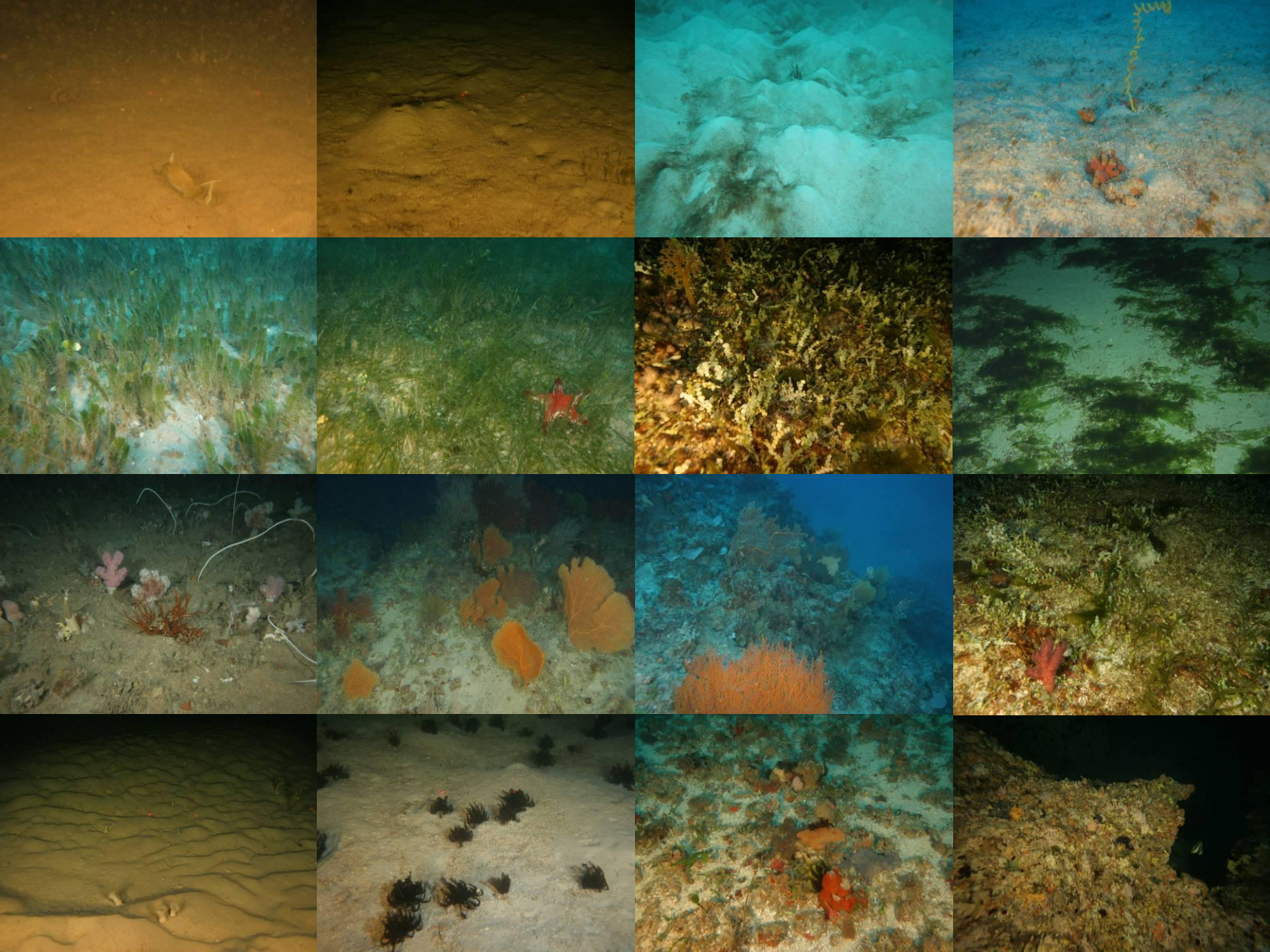
Seabed fish & bycatch samples



Trawl and benthic sites sampled



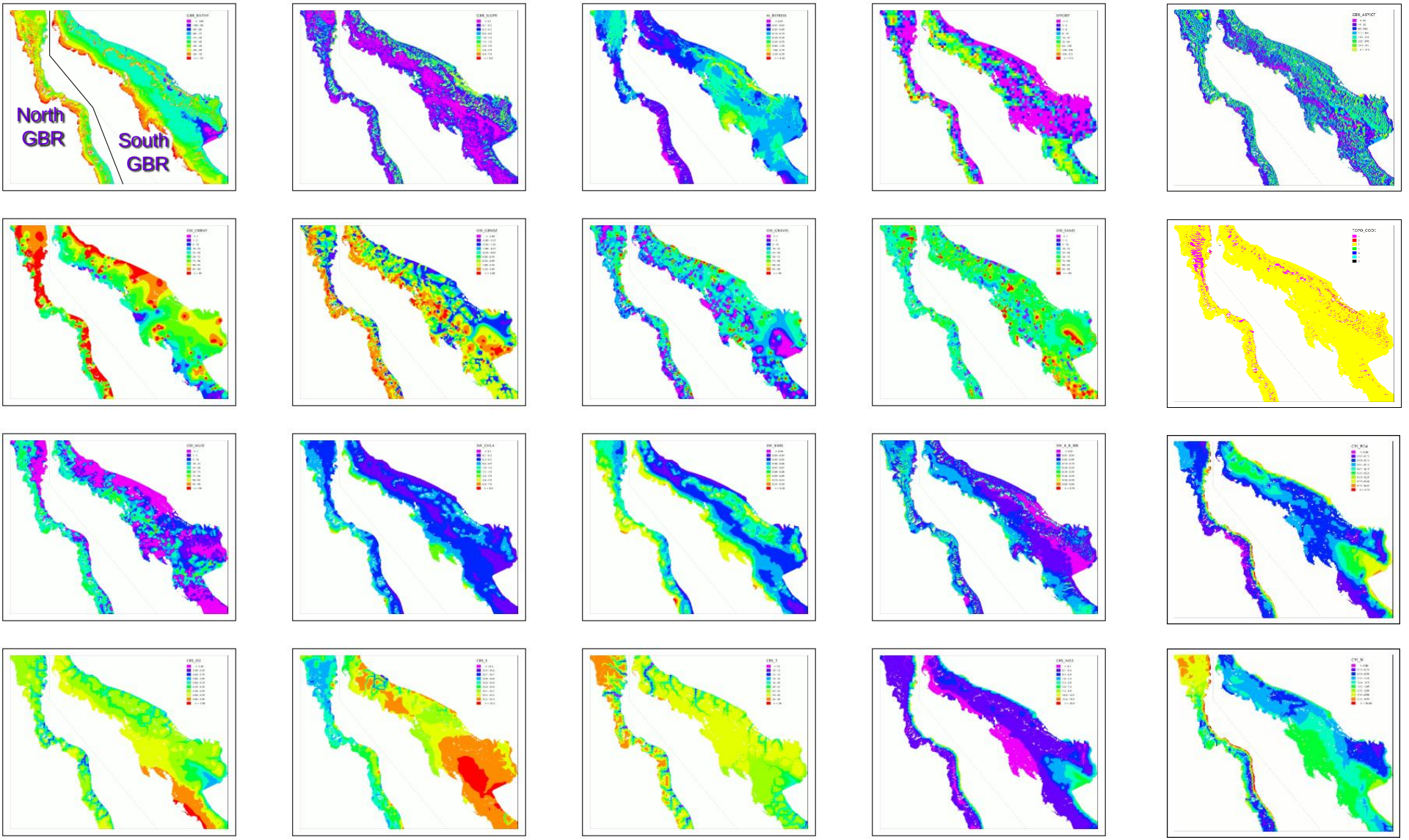




>7,000 taxa identified, many new species

Collated 28 physical environment covariates

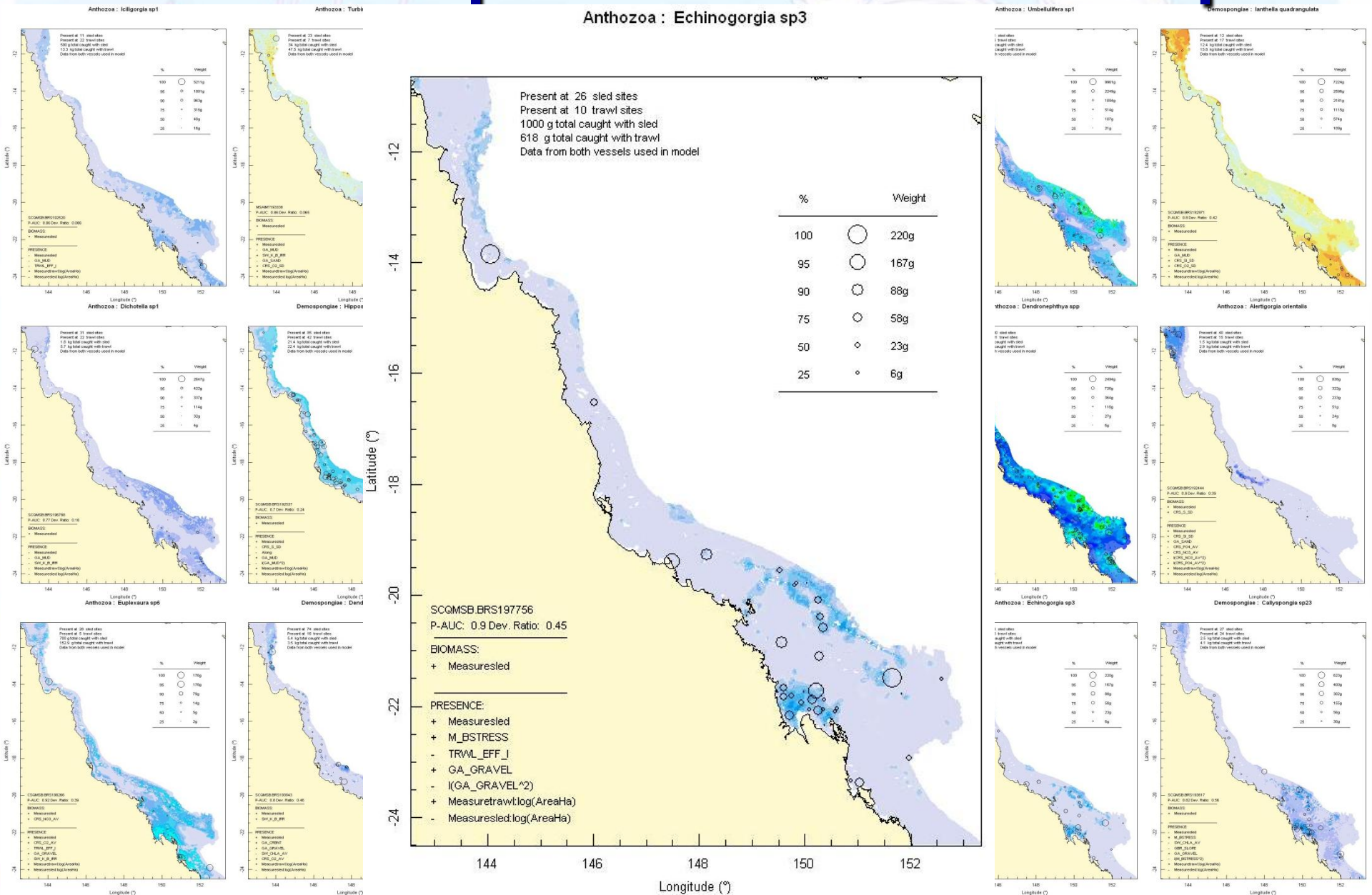
- eg.Bathymetry, slope, current stress, sediments, turbidity, nutrients, fishing etc



Biomass scale (g/ha)

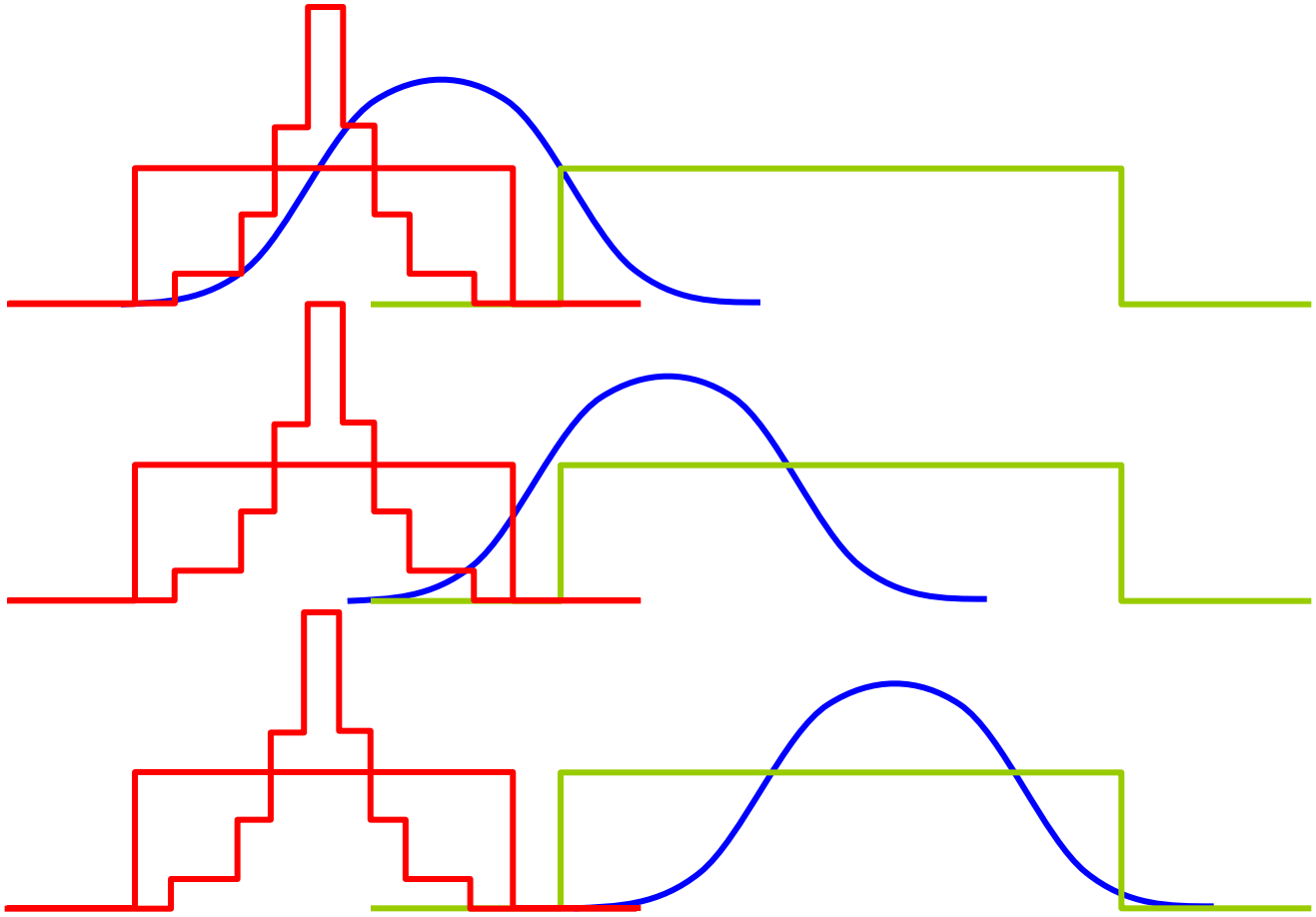
16384g 8192g 4096g 2048g 1024g 512g 256g 128g 64g 32g 16g 8g 4g

Predicted species distribution maps



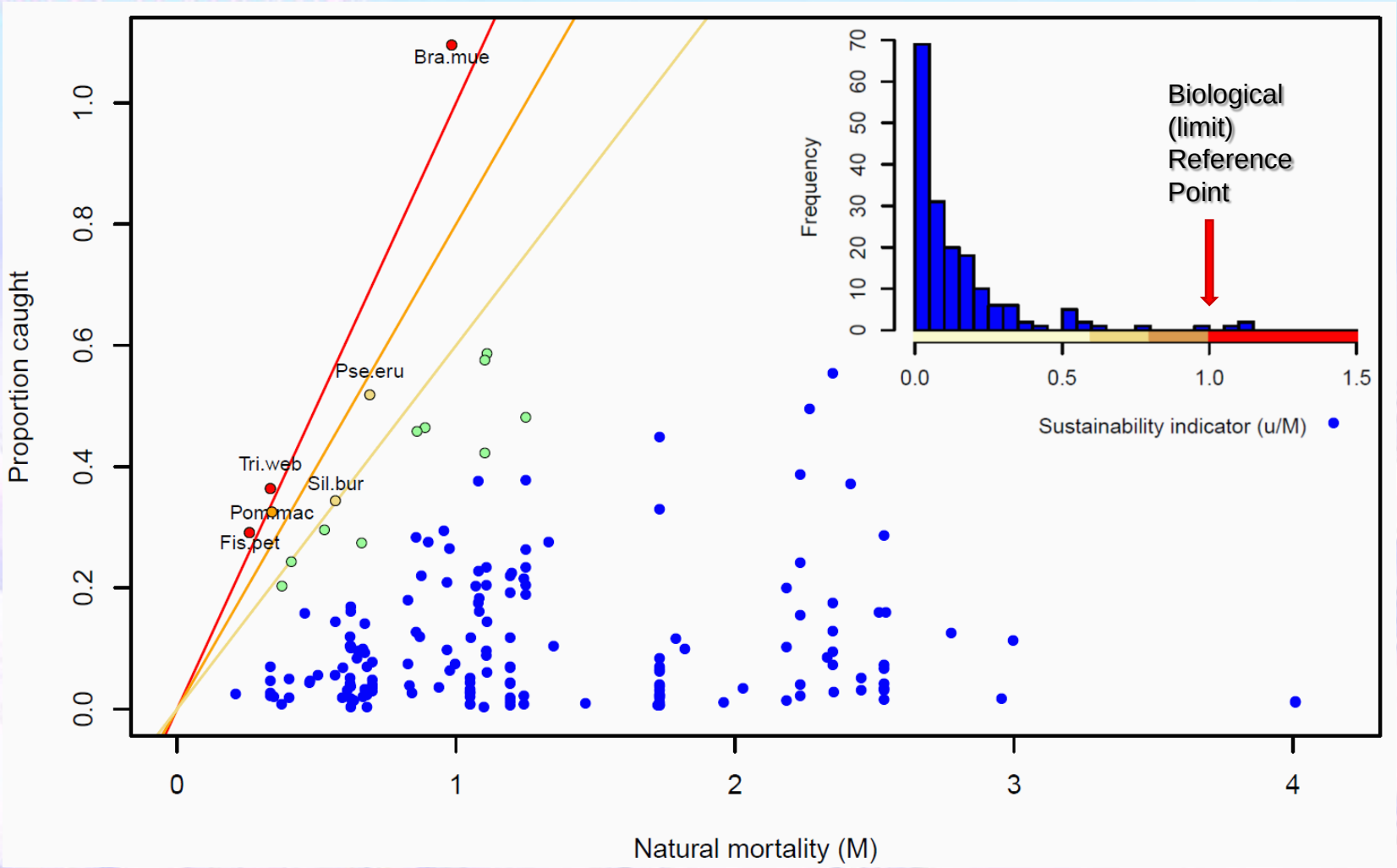
Trawl Exposure Indicators: for ~850 species

Rank	Class	Genus Species	%Protected
1	Crustacea	*Penaeus semisulcatus*	26



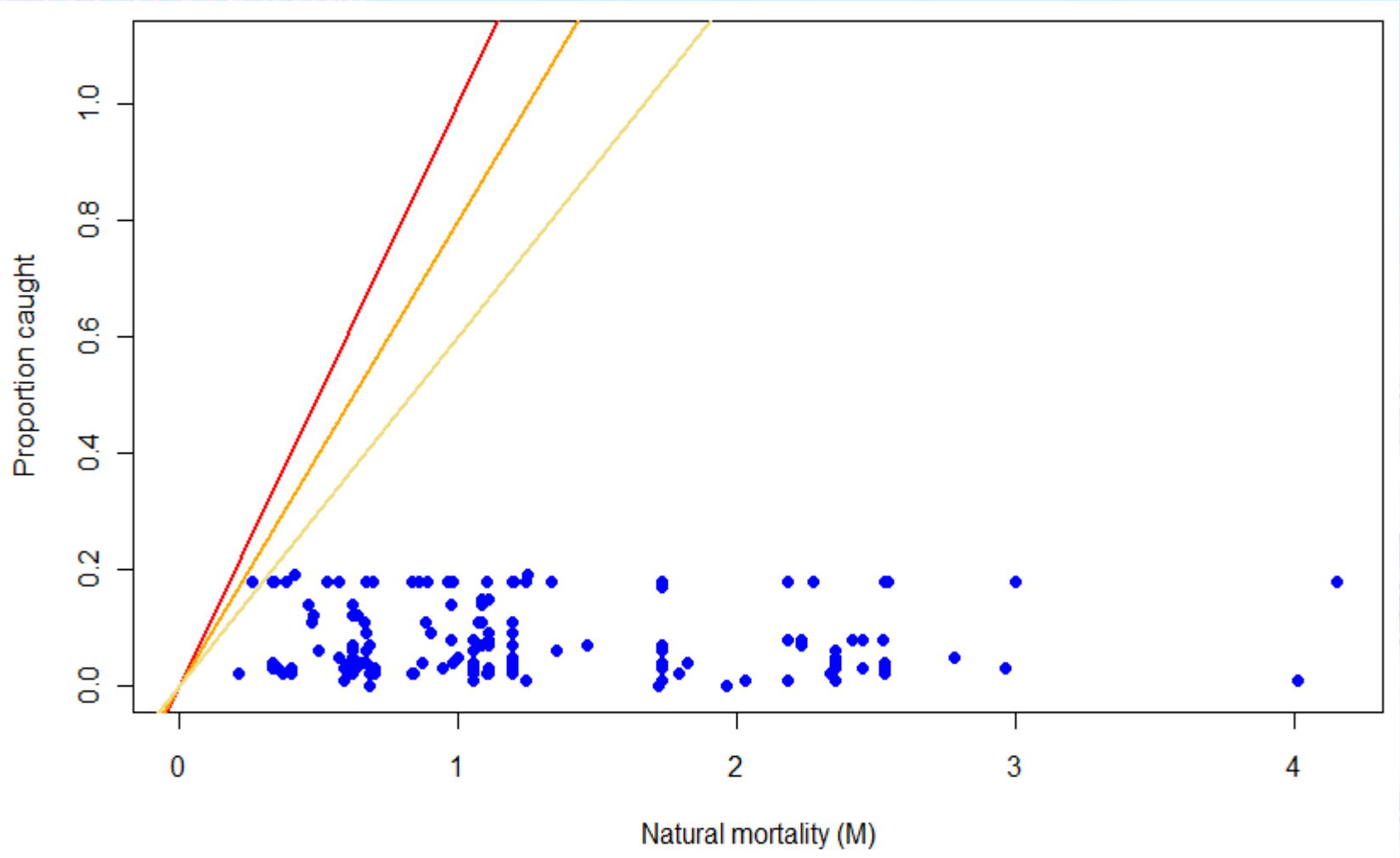
Sensitivity of indicators

- Frequency distributions for species, by indicator

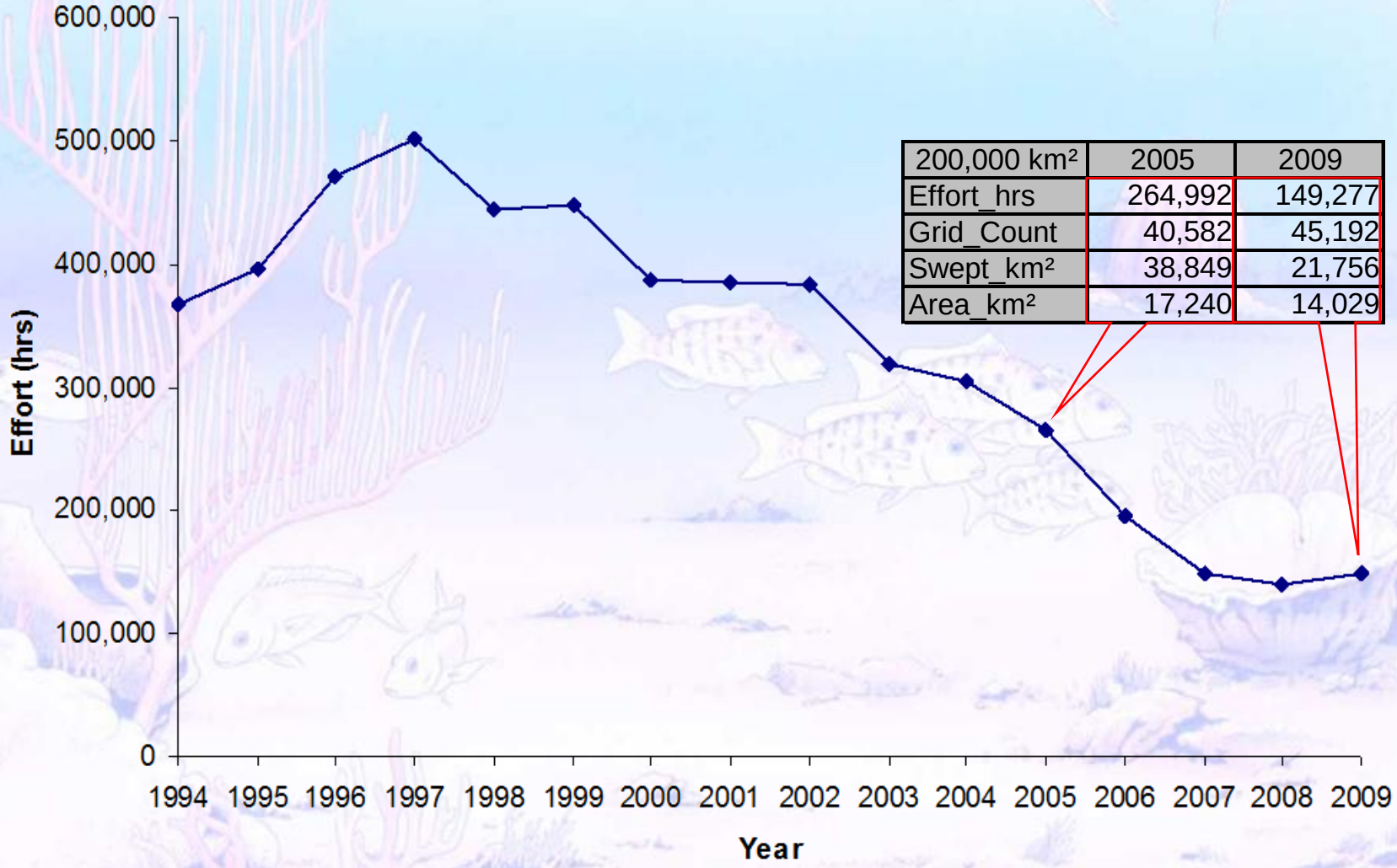


Indicators without species distributions

- Frequency distributions for species, by indicator

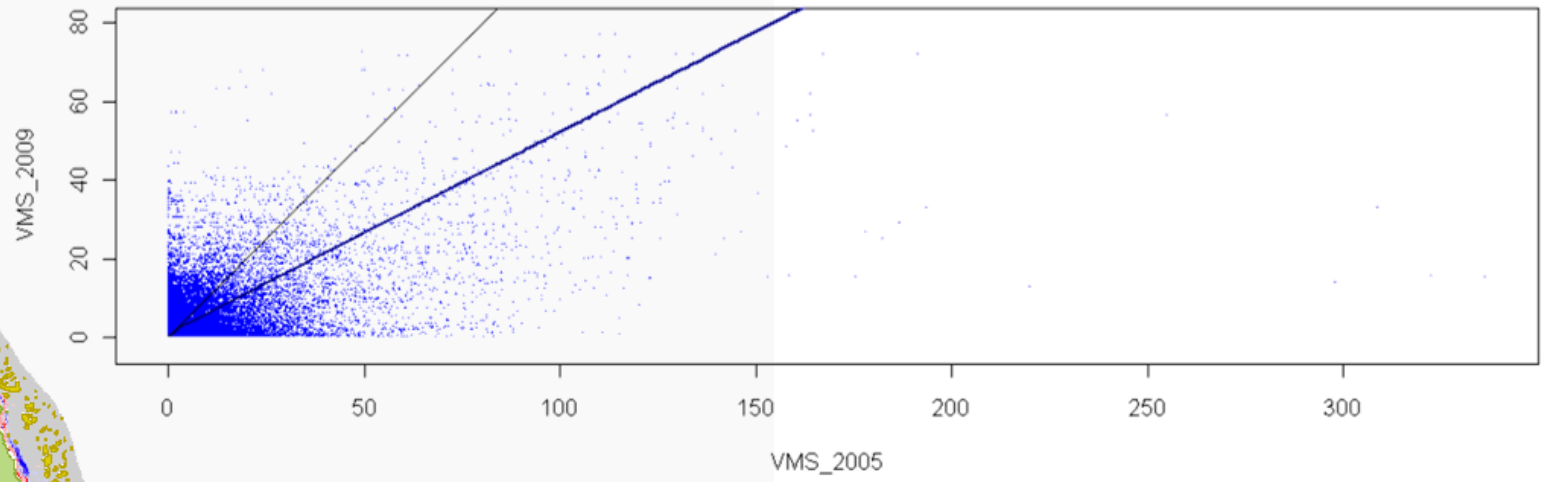


2009 update: trawl effort trends



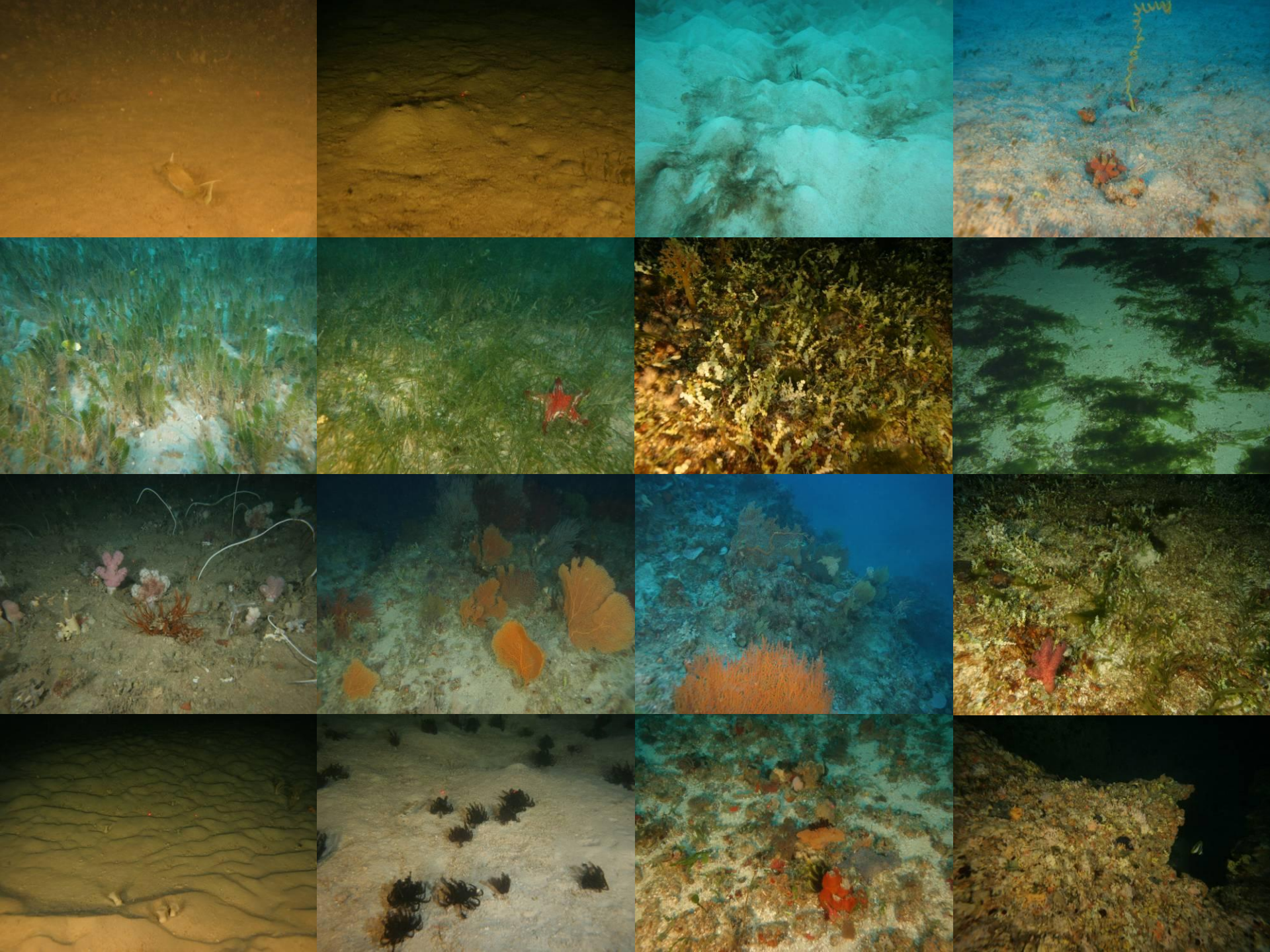
200,000 km²	2005	2009
Effort_hrs	264,992	149,277
Grid_Count	40,582	45,192
Swept_km²	38,849	21,756
Area_km²	17,240	14,029

2009 update: trawl effort comparison

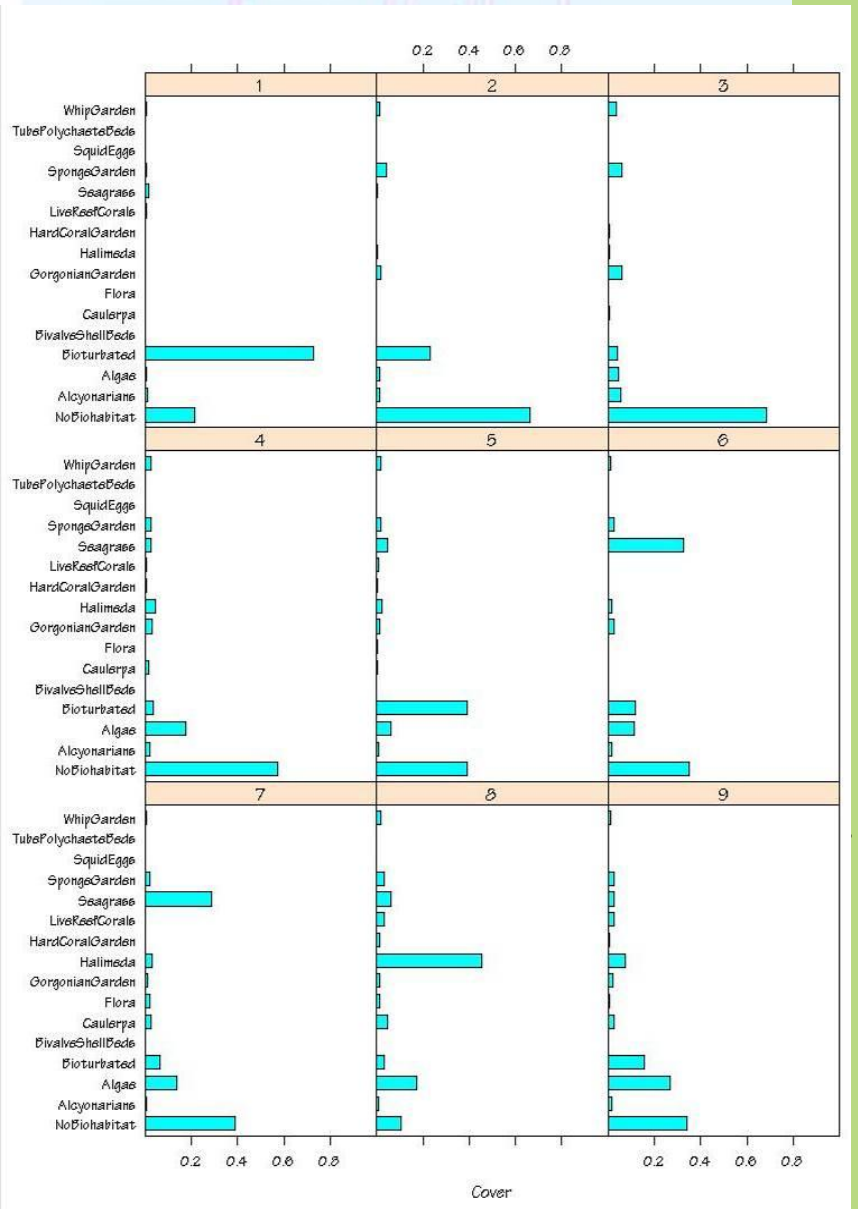


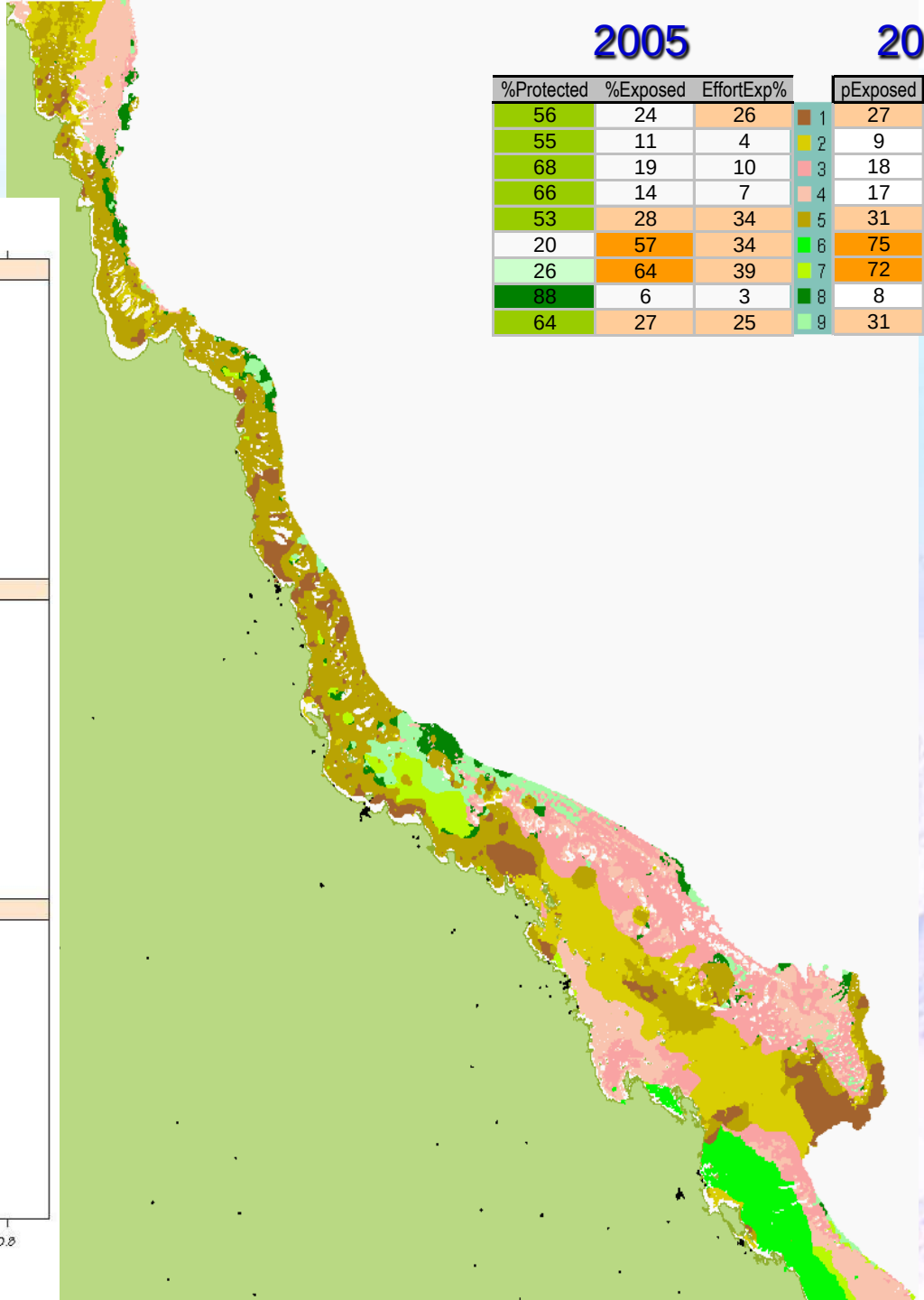
Difference

CLASS	GENUS	SPECIES	%Protected	%Exposed	%EffortExp	Rel_Catch	Uncertainty	BRD	pCaught	M_est	C_REL_M		pExposed	pEffortExp	pCaught	C_REL_M
Crustacea	Penaeus	semisulcatus	26	64	174	0.32	0.18		55	2.35	0.24		66	63	20	0.09
Crustacea	Cryptolutea	arafurensis	43	41	128	0.03	0.01		4				40	42	1	
Actinopterygii	Brachirus	muelleri	31	59	119	1.00		0.92	110	0.98	1.11		57	37	34	0.34
Actinopterygii	Pentaprion	longimanus	38	48	117	0.11	0.00	0.92	12	1.79	0.07		51	44	4	0.02
Actinopterygii	Pelates	quadrilineatus	31	47	103	0.15	0.00	0.92	14	1.11	0.13		58	38	5	0.05
Actinopterygii	Leiognathus	leuciscus	41	43	95	0.43	0.87	0.92	37	2.41	0.15		46	32	13	0.05
Actinopterygii	Upeneus	sundaicus	37	50	93	0.45	0.61	0.92	39	2.23	0.17		53	32	13	0.06
Crustacea	Portunus	gracilimanus	41	38	86	0.39	0.13		33	1.73	0.19		42	31	12	0.07
Actinopterygii	Terapon	puta	44	47	78	0.82	1.26	0.92	59	1.11	0.53		51	25	19	0.17
Bivalvia	Enisiculus	cultellus	39	46	75	0.07	0.05		5				49	31	2	
Actinopterygii	Brachaluteres	taylori	29	60	72	0.13	0.08	0.92	9	2.33	0.04		65	50	6	0.03
Crustacea	Trachypenaeus	anchoralis	36	44	67	0.26	0.13		18	2.35	0.07		53	26	7	0.03
Crustacea	Metapenaeus	ensis	33	49	67	0.19	0.27		13	2.35	0.06		55	30	6	0.02
Crustacea	Erugosquilla	woodmasoni	34	49	65	0.18	0.40		12	0.87	0.14		54	25	5	0.05
Actinopterygii	Leiognathus	bindus	58	28	63	0.01	0.12	0.92	1	1.72	0.00		30	23	0	0.00
Bivalvia	Melaxinaea	vitrea	41	38	63	0.07	0.04		5				40	25	2	
Actinopterygii	Saurida	argentea/tumbil complex	42	38	63	1.00		0.92	58	1.10	0.52		40	25	23	0.21
Actinopterygii	Terapon	theraps	37	43	62	0.11	0.17	0.92	6	1.11	0.05		47	26	3	0.02
Crustacea	Myra	tumidospina	43	38	60	0.13	0.05		8				41	23	3	
Actinopterygii	Calliurichthys	grossi	46	39	59	0.43	0.26	0.92	23	1.11	0.21		42	22	9	0.08
Crustacea	Thenus	parindicus	45	36	57	0.49	0.42		28	0.90	0.31		39	21	10	0.12
Gastropoda	Nassarius	cremmatus cf	45	39	57	0.03	0.01		1				41	22	1	
Actinopterygii	Psettodes	erumei	39	40	56	1.00		0.92	52	0.69	0.75		43	21	20	0.28
Bivalvia	Placamen	tiara	45	35	55	0.04	0.02		2				37	22	1	
Actinopterygii	Scolopsis	taeniopterus	49	33	54	1.00		0.92	50	2.27	0.22		35	20	18	0.08
Bivalvia	Amusium	pleuronectes cf	40	37	52	0.73	0.28		38	1.08	0.35		40	20	15	0.14
Actinopterygii	Yongeichthys	nebulosus	58	25	51	1.00		0.92	47	4.15	0.11		25	16	15	0.04
Actinopterygii	Apogon	poecilopterus	50	34	51	0.95	0.39	0.92	45	1.73	0.26		37	20	17	0.10
Actinopterygii	Euristhmus	nudiceps	44	33	51	1.00		0.92	47	0.89	0.52		35	19	17	0.20
Actinopterygii	Tripodichthys	angustifrons	55	36	50	1.00		0.92	46	0.86	0.53		38	17	15	0.18
Anthozoa	Sea pen	sp1	43	37	50	0.16	0.13		8				43	20	3	
Cephalopoda	Sepia	pharaonis	49	34	48	1.00			48	1.25	0.39		37	19	19	0.16
Actinopterygii	Nemipterus	peronii	36	37	48	0.62	0.75	0.92	27	0.66	0.41		41	19	11	0.16
Actinopterygii	Saurida	grandi/undo complex	41	37	46	1.00		0.92	42	1.10	0.38		43	23	21	0.19
Crustacea	Charybdis	truncata	52	31	46	0.39	0.14		18				33	17	7	
Crustacea	Portunus	tuberculosus	53	31	46	0.06	0.03		3				34	19	1	
Actinopterygii	Trixiphichthys	weberi	44	32	40	1.00	0.36	0.92	36	0.33	1.09		37	17	16	0.47
Cephalopoda	Sepia	elliptica	49	30	38	1.00			38	1.25	0.30		33	15	15	0.12
Gastropoda	Aplysia	sp1_QMS	49	32	38	1.00			38				37	17	17	
Gastropoda	Lamellaria	sp1	54	27	37	1.00			37				29	15	15	
Actinopterygii	Sillago	burrus	54	30	37	1.00		0.92	34	0.57	0.60		37	16	14	0.25
Crustacea	Diogenidae	sp356-1	55	25	36	0.07	0.04		3				27	15	1	
Actinopterygii	Pomadasys	maculatus	35	35	35	1.00		0.92	33	0.34	0.96		39	13	12	0.36
Actinopterygii	Nemipterus	furcosus	50	25	32	1.00		0.92	30	0.53	0.56		25	13	12	0.23
Actinopterygii	Nemipterus	hexodon	48	21	32	1.00		0.92	29	0.96	0.31		21	12	11	0.11
Actinopterygii	Fistularia	petimba	56	26	32	1.00		0.92	29	0.26	1.12		28	13	12	0.48
Actinopterygii	Chaetodermis	penicilligera	41	38	31	1.00		0.92	29	2.53	0.11		44	18	17	0.07
Actinopterygii	Nemipterus	sp juv/unident	53	28	31	1.00		0.92	28	0.86	0.33		31	14	13	0.15
Cephalopoda	Sepia	whitleyana	50	32	26	1.00			26	1.25	0.21		37	15	15	0.12
Chondrichthyes	Dasyatis	leylandi	56	24	24	1.00			24	0.41	0.59		26	11	11	0.27
Cephalopoda	Sepia	smithi	55	26	23	1.00			23	1.25	0.19		29	11	11	0.09
Actinopterygii	Polydactylus	multiradiatus	70	20	22	1.00		0.92	20	0.38	0.54		24	8	8	0.21
Actinopterygii	Pristotis	obtusirostris	57	27	21	0.81	0.35	0.92	16	0.46	0.35		31	12	9	0.20



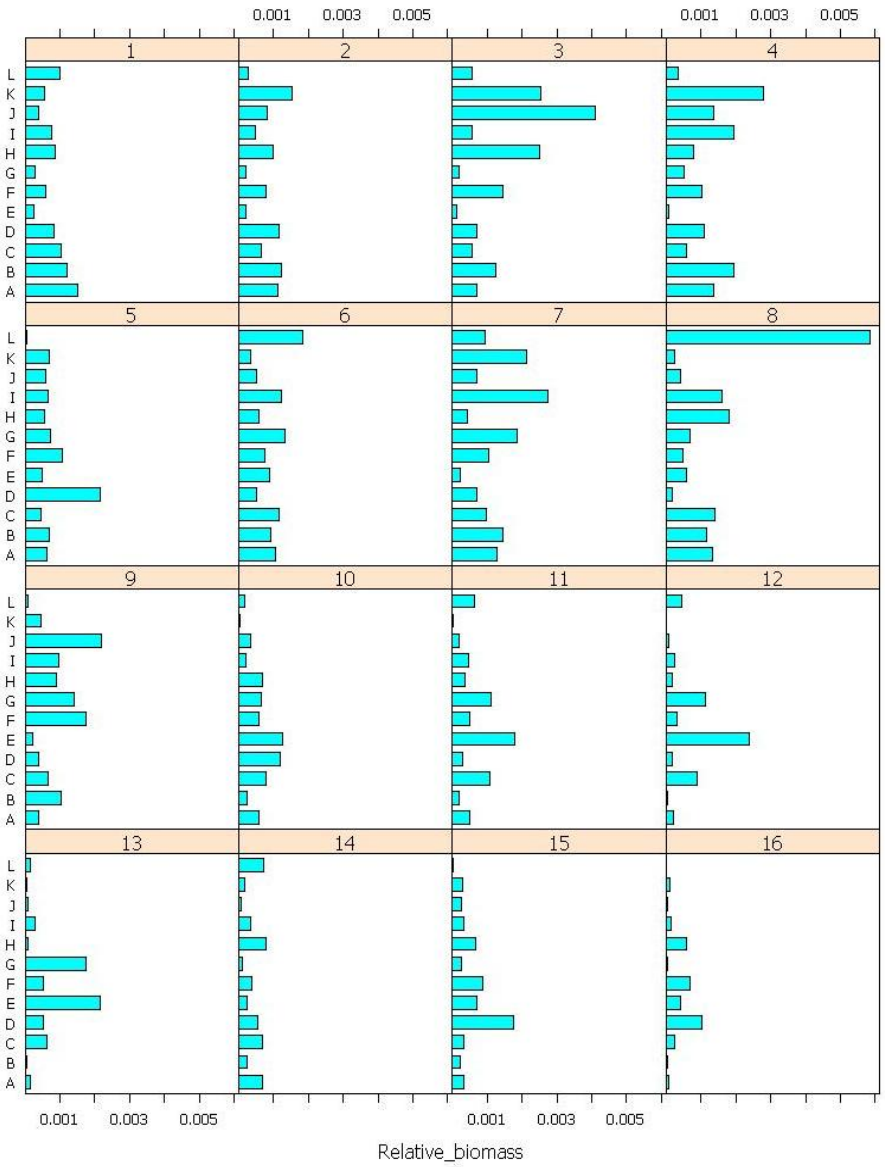
Seabed habitats





2005				2009	
%Protected	%Exposed	EffortExp%		pExposed	pEffortExp
56	24	26	1	27	12
55	11	4	2	9	1
68	19	10	3	18	4
66	14	7	4	17	5
53	28	34	5	31	15
20	57	34	6	75	34
26	64	39	7	72	30
88	6	3	8	8	3
64	27	25	9	31	20

Seabed assemblages



%Protected	%Exposed	EffortExp%		pExposed	pEffortExp
49	42	32	1	45	28
62	19	8	2	16	3
84	8	2	3	10	2
30	56	41	4	63	27
45	19	10	5	15	2
49	28	13	6	34	8
31	43	21	7	65	24
71	4	3	8	4	2
84	2	0	9	3	0
44	10	2	10	9	1
43	42	58	11	43	23
43	52	108	12	53	46
27	58	41	13	72	26
90	0	0	14	0	0
84	1	0	15	3	0
95	0	0	16	3	0

Summary

- Distributions are critical for assessment
  - Prediction from environmental variables is useful
- Quantitative risk indicators → absolute sustainability
  - Analogous to stock assessment of target species
    - Proportion caught relative to demographic rate
  - Compare against established biological reference points
- Very few of 100s of species appeared to be at risk
- Intensity & footprint decreasing → reduced risk