Estimates of sustainable catch and effort levels for target species and the impacts on stocks of potential management measures

Acknowledgements

Co-authors

- Adam Langley (SPC)
- Shelton Harley (MAF, NZ)
- Pierre Kleiber (NMFS, USA)
- Yukio Takeuchi (NRIFSF, Japan)
- Momoko Ichinokawa (NRIFSF)

WCPFC 1 Resolution – Para 1

a) Estimates of both sustainable catch and effort levels for bigeye, yellowfin and South Pacific albacore

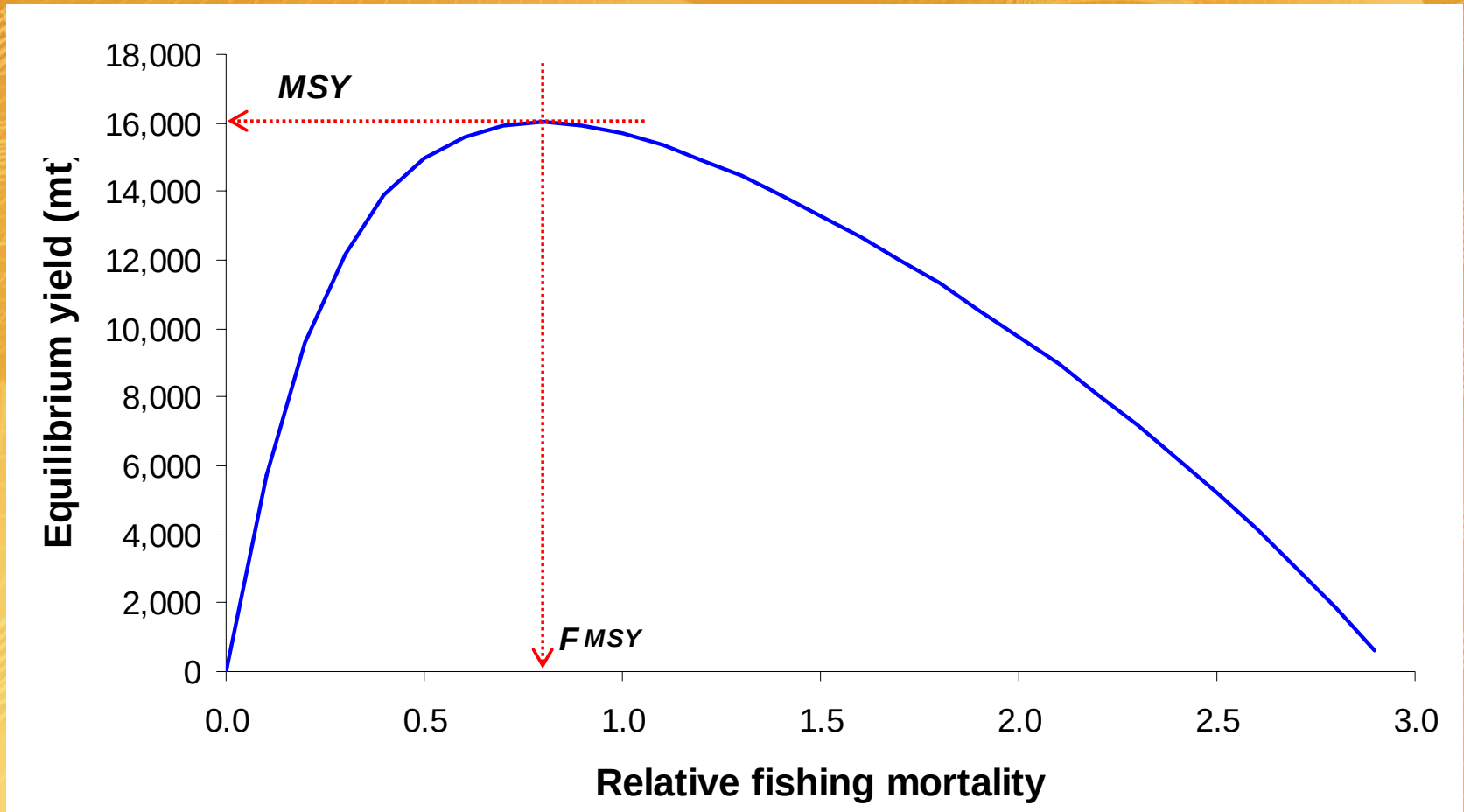
b) Five and ten year projections of total biomass and spawning stock biomass for bigeye and yellowfin tuna under: 2003 catch and effort levels, and possible scenarios of changes in catch and effort in the Convention Area for the purse seine, longline and other surface fisheries which have a major impact on bigeye tuna and yellowfin tuna; including the effects on the stocks of possible time/area closures by fishing method for bigeye and yellowfin tuna

c) The effects on the stocks of measures to mitigate the catch of juvenile bigeye and yellowfin including controls on setting on floating objects

Sustainable Catch and Effort

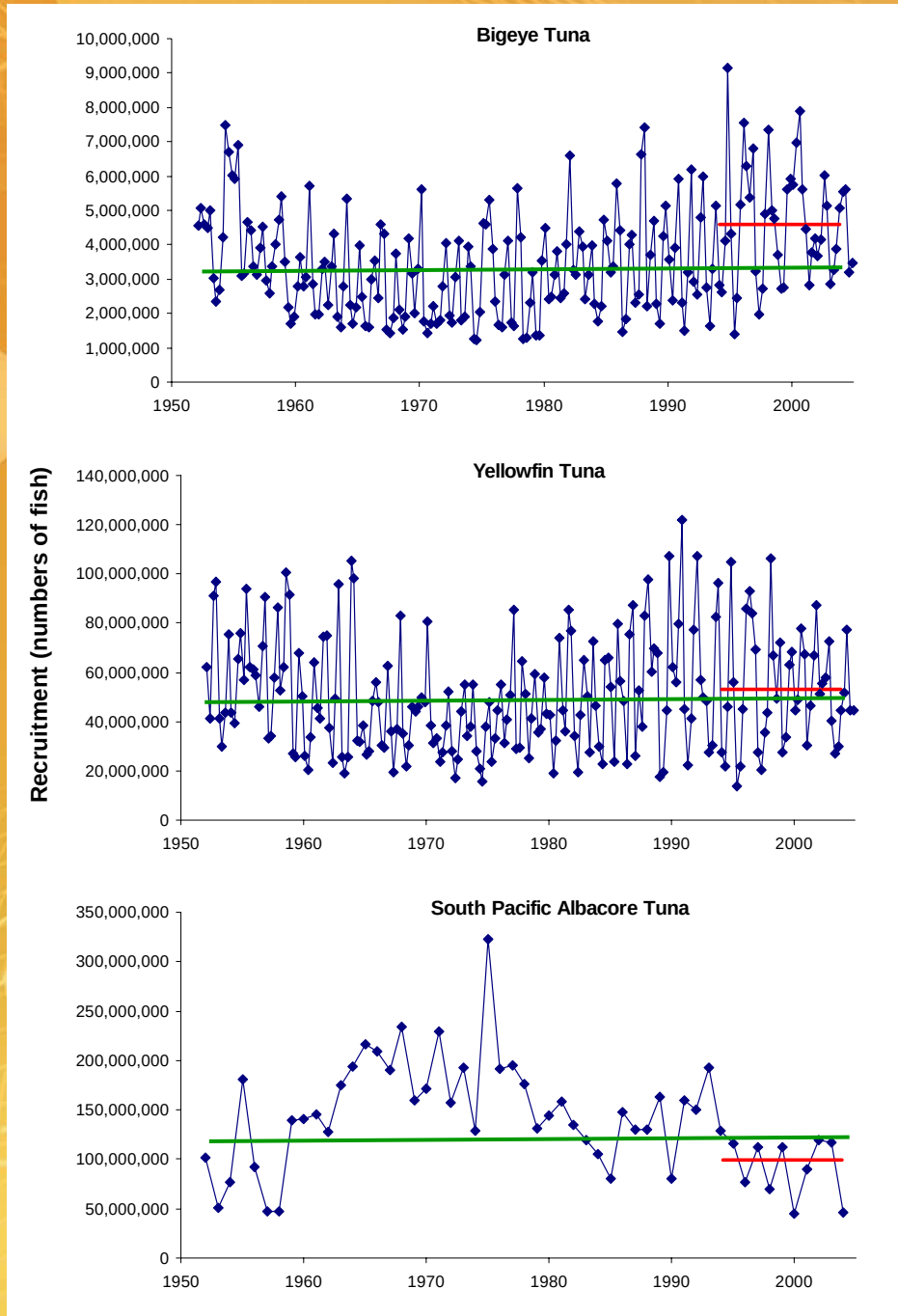
- What is “sustainable”?
  - Sustaining populations (biological question)
  - Sustaining fisheries (biological and economic)
- MSY-based reference point approach
  - Addresses the biological considerations of sustaining populations
- There are other approaches that could be applied
  - E.g. simple biomass depletion reference points

MSY-Based Reference Points



Recruitment variability

- MSY estimates based on long-term equilibrium recruitment may not reflect the current levels of stock productivity
- More realistic to use recent average recruitment for short-term catch limits



Estimates of Sustainable Catch and Effort

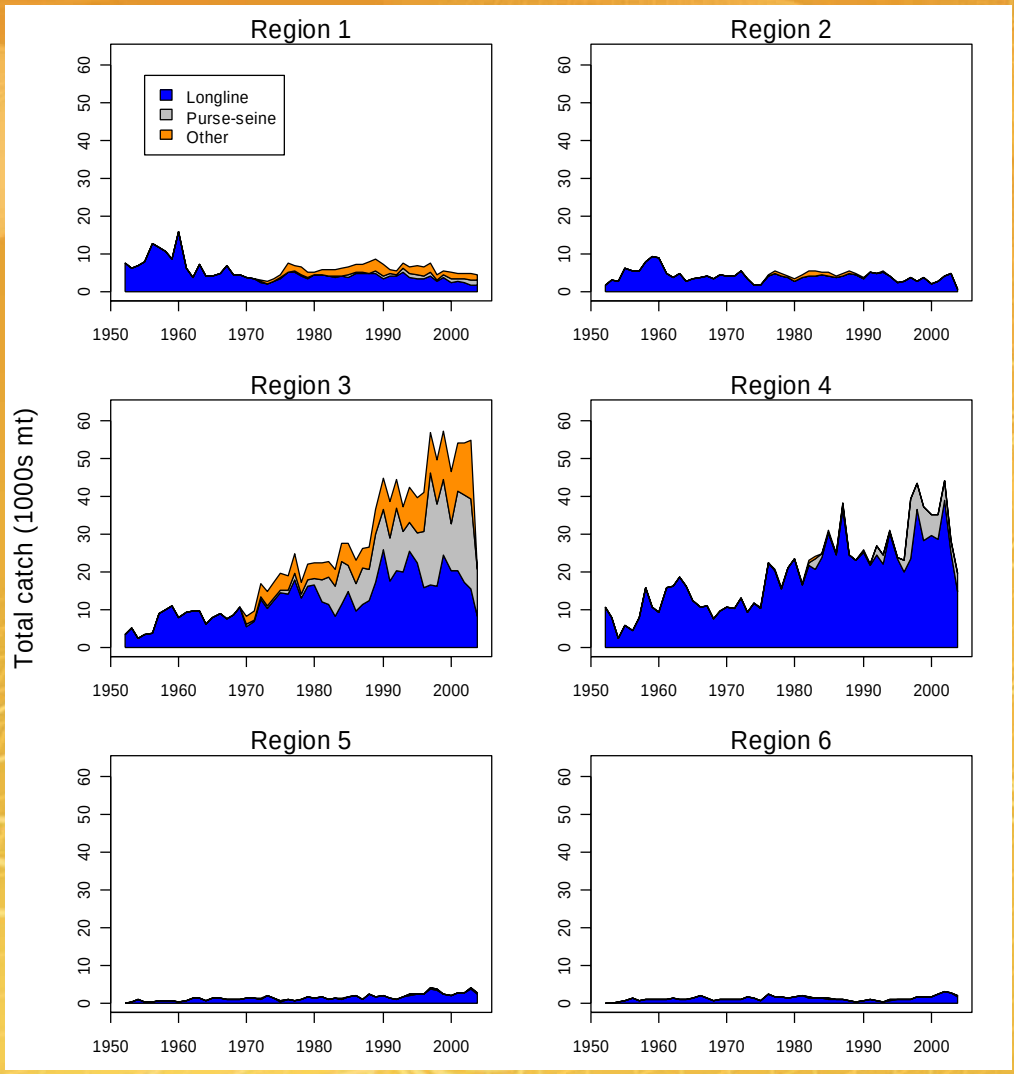
Stock	F_{MSY} relative to "current" F	MSY BH recruitment	MSY relative to "current" model catch	Maximum Yield 1994–2003 Average Recruitment	Maximum yield relative to "current" model catch
Bigeye tuna (WCPO)	0.81	66,040 (62,222–69,858)	0.67	93,300	0.95
Yellowfin tuna (WCPO)	0.82	262,400 (229,790–295,010)	0.65	312,200	0.77
South Pacific albacore	19.10	183,000 (73,100–292,300)	3.55	156,700	3.04

Estimates of Sustainable Effort

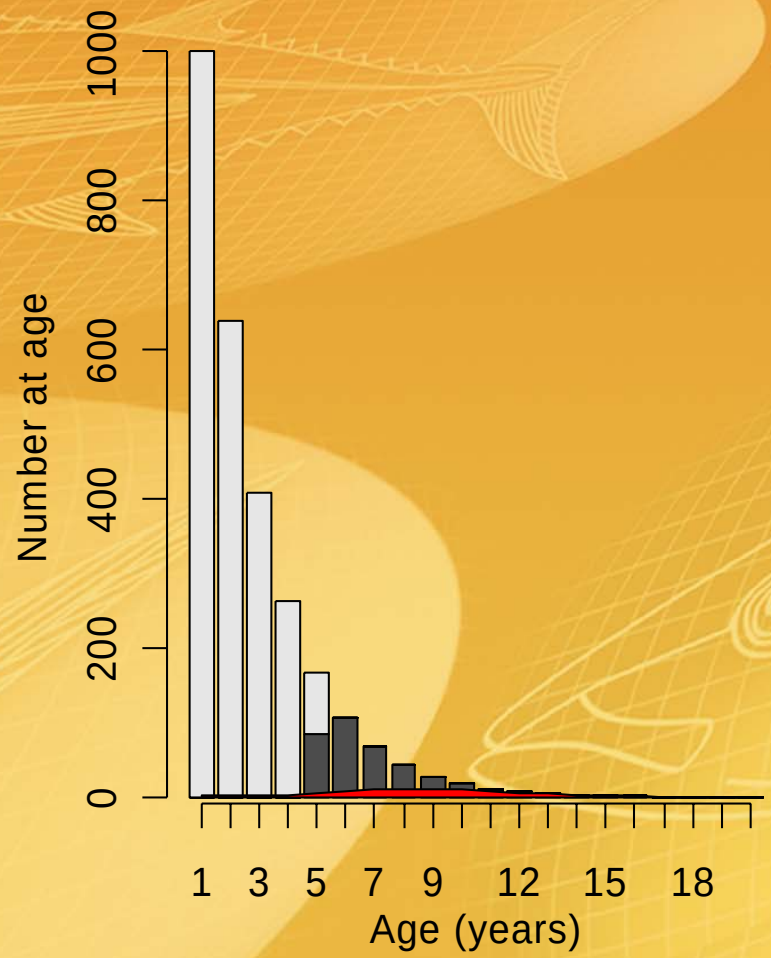
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total
Longline							
2001	29.15	24.64	234.45	135.11	44.86	90.00	558.20
2002	24.09	29.55	256.82	196.58	64.99	114.48	686.50
2003	22.59	37.89	212.16	120.52	79.88	117.52	590.55
Average	25.28	30.69	234.47	150.73	63.24	107.33	611.75
Bigeye F_{MSY}	20.47	24.86	189.92	122.09	51.23	86.94	495.52
Yellowfin F_{MSY}	20.73	25.17	192.27	123.60	51.86	88.01	501.64
Purse seine							
2001			25,292	12,449			37,741
2002			24,654	16,081			40,735
2003			39,831	4,949			44,779
Average			29,926	11,159			41,085
Bigeye F_{MSY}			24,240	9,039			33,279
Yellowfin F_{MSY}			24,539	9,150			33,690

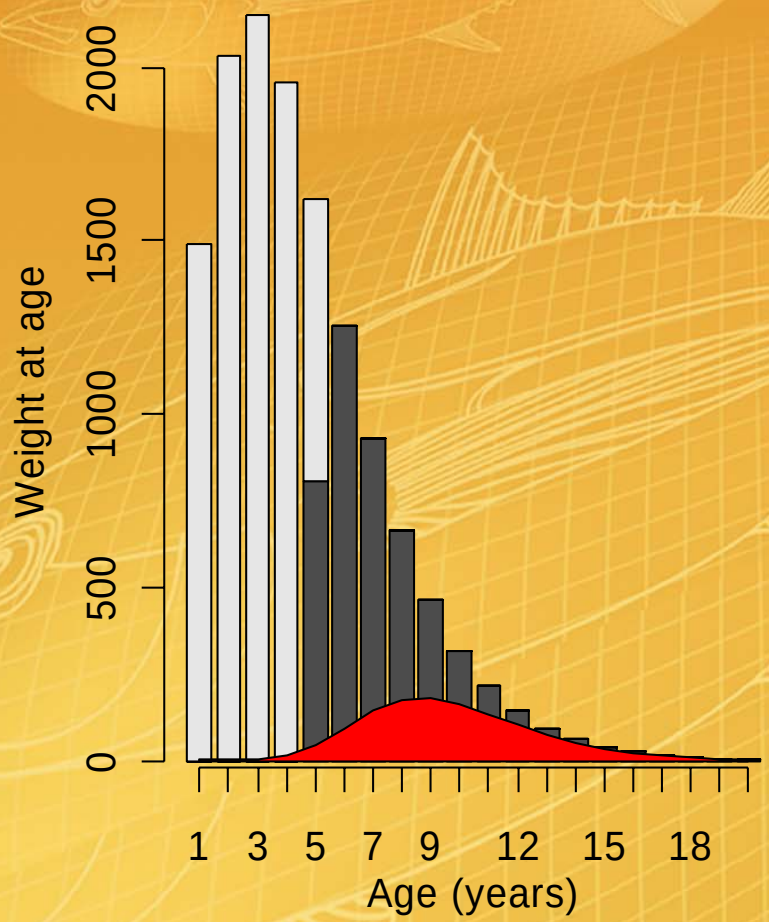
Estimates of Sustainable Catch and Effort

- Key assumption – current overall fishery selectivity (i.e. mix of gear types) remains constant

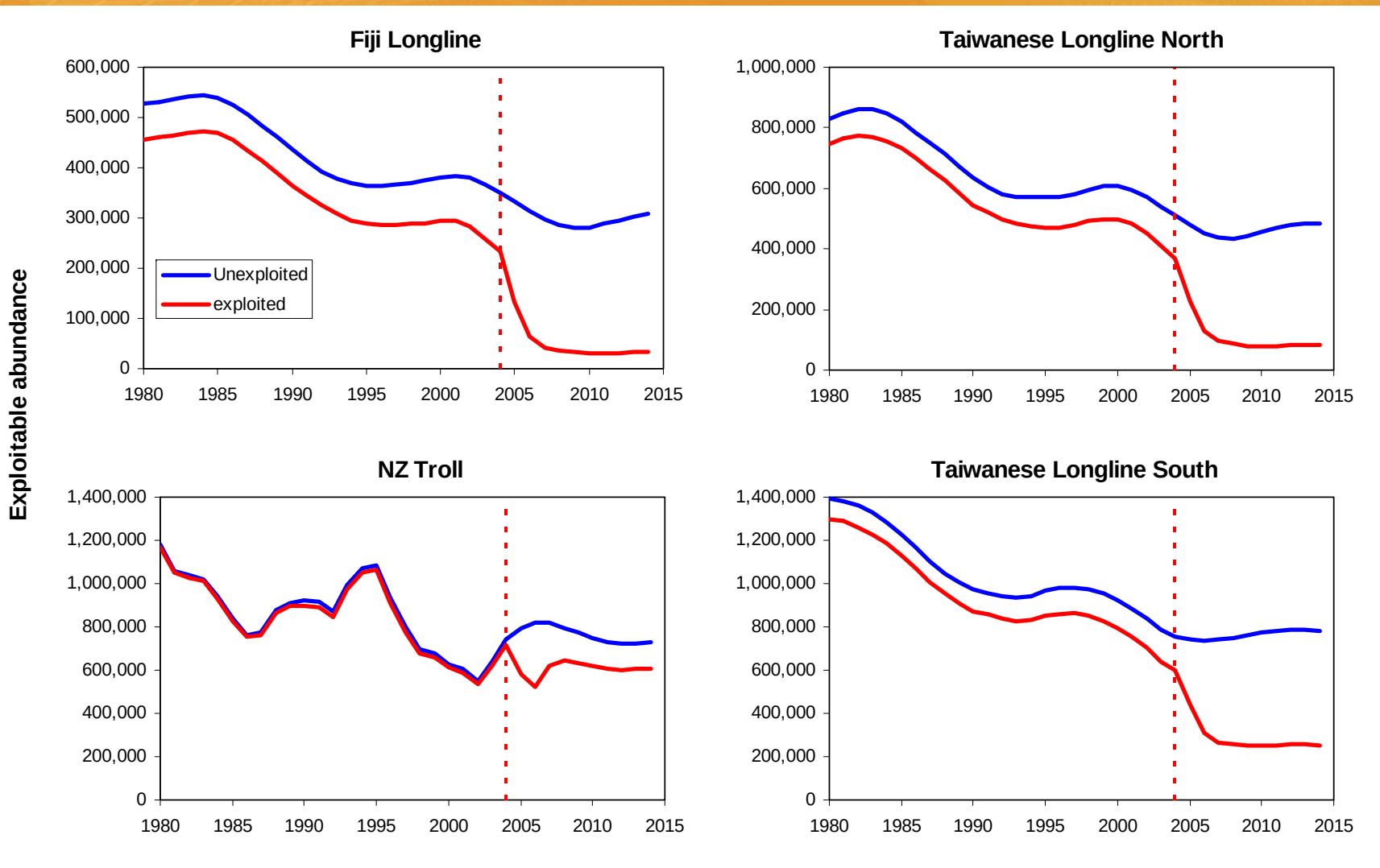


Albacore - why is MSY so high?





Albacore – consequences of MSY levels of effort?



Bigeye and Yellowfin Projections

- Addressing 1 (b) and (c) of Resolution
- No treatment of uncertainty – but results are very uncertain in absolute terms
- No multi-species interactions considered
- Regions/seasons considered are according to the MULTIFAN-CL stratification
- Projections from 2005 – 2014 using 2003 catch and effort as a base
- Future catchability assumed to be as in 2004
- Future recruitment predicted by
  - BH stock-recruitment relationship
  - 1994-2003 average recruitment
- 15% and 30% reductions from 2003 considered
- Effort redistribution – to other areas or (PS) to other set type

Projection Runs

Run 1	2003 catches
Run 2	2003 effort
Run 3	Purse seine catch/effort reductions
Run 4	Longline catch/effort reductions
Run 5	Indonesia/Philippines catch/effort reduction
Run 6	Catch/effort reductions in all fisheries
Run 7	Ban on log/FAD sets (effort to school sets)
Run 8	50% reduction in log/FAD set catchability
Run 9	Seasonal closures of PS log/FAD sets area 3 (effort to school sets, area 3)
Run 9A	Seasonal closures of all PS area 3 (effort to area 4)
Run 10	Seasonal closures of PS log/FAD sets area 4 (effort to school sets, area 4)
Run 10A	Seasonal closures of all PS area 4 (effort to area 3)
Run 11	Seasonal closures of longlining, area 3
Run 12	Seasonal closures of longlining, area 4

Projection Output

Run	Year	BH Recruitment R1	R2	R3	R4	R5	R6	Total	B/B_{MSY}	1994-2003 Average Recruitment R1	R2	R3	R4	R5	R6	Total	B/B_{MSY}
1	2009	1.63	1.40	0.01	0.94	0.50	0.70	0.71	0.89	1.30	1.13	0.01	1.43	0.72	0.82	0.89	1.10
	2014	1.70	1.37	0.00	0.74	0.40	0.63	0.62	0.77	1.22	1.01	0.01	1.44	0.67	0.80	0.87	1.08
2	2009	1.44	1.28	0.31	0.88	0.67	0.77	0.77	0.96	1.17	1.07	0.56	1.21	0.81	0.86	0.96	1.19
	2014	1.45	1.25	0.31	0.83	0.66	0.76	0.74	0.92	1.12	1.01	0.56	1.22	0.81	0.87	0.95	1.18
3a	2009	1.63	1.40	0.01	0.97	0.50	0.70	0.73	0.90	1.30	1.13	0.01	1.46	0.72	0.82	0.90	1.12
	2014	1.70	1.37	0.01	0.78	0.40	0.63	0.64	0.79	1.22	1.01	0.01	1.48	0.67	0.80	0.89	1.10
3b	2009	1.63	1.40	0.01	0.99	0.50	0.70	0.74	0.92	1.30	1.13	0.01	1.50	0.72	0.82	0.92	1.14
	2014	1.70	1.37	0.01	0.81	0.40	0.64	0.66	0.81	1.22	1.01	0.01	1.52	0.67	0.80	0.90	1.12
3c	2009	1.44	1.28	0.34	0.90	0.67	0.77	0.79	0.98	1.17	1.07	0.61	1.24	0.81	0.86	0.99	1.22
	2014	1.45	1.26	0.34	0.85	0.66	0.76	0.76	0.95	1.12	1.01	0.61	1.24	0.81	0.87	0.98	1.21
3d	2009	1.44	1.28	0.38	0.92	0.67	0.77	0.81	1.00	1.17	1.07	0.68	1.26	0.81	0.86	1.02	1.26
	2014	1.45	1.26	0.37	0.87	0.66	0.76	0.78	0.97	1.12	1.01	0.68	1.27	0.81	0.87	1.01	1.25
																90	0.95	1.18
																88	0.94	1.17
																98	1.01	1.26
																97	1.01	1.26
																91	1.01	1.25
																91	1.00	1.24
																96	1.07	1.32
																97	1.06	1.32
																82	0.89	1.11
																80	0.87	1.08
																82	0.90	1.11
																80	0.87	1.08
																86	0.98	1.21
																87	0.97	1.20
																86	1.00	1.24
																87	0.99	1.23
																90	0.97	1.20
																88	0.96	1.19
																99	1.24	1.53
																97	1.23	1.53
																91	1.06	1.31
																92	1.05	1.31
																97	1.19	1.47
																97	1.19	1.47
																86	1.17	1.46
																87	1.17	1.45
																86	1.06	1.31
																87	1.05	1.30
																86	0.99	1.22
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Run	Year	BH Recruitment R1	R2	R3	R4	R5	R6	Total	B/B_{MSY}
1	2009	1.63	1.40	0.01	0.94	0.50	0.70	0.71	0.89
	2014	1.70	1.37	0.00	0.74	0.40	0.63	0.62	0.77
2	2009	1.44	1.28	0.31	0.88	0.67	0.77	0.77	0.96
	2014	1.45	1.25	0.31	0.83	0.66	0.76	0.74	0.92
3a	2009	1.63	1.40	0.01	0.97	0.50	0.70	0.73	0.90
	2014	1.70	1.37	0.01	0.78	0.40	0.63	0.64	0.79
3b	2009	1.63	1.40	0.01	0.99	0.50	0.70	0.74	0.92
	2014	1.70	1.37	0.01	0.81	0.40	0.64	0.66	0.81
3c	2009	1.44	1.28	0.34	0.90	0.67	0.77	0.79	0.98
	2014	1.45	1.26	0.34	0.85	0.66	0.76	0.76	0.95
3d	2009	1.44	1.28	0.38	0.92	0.67	0.77	0.81	1.00
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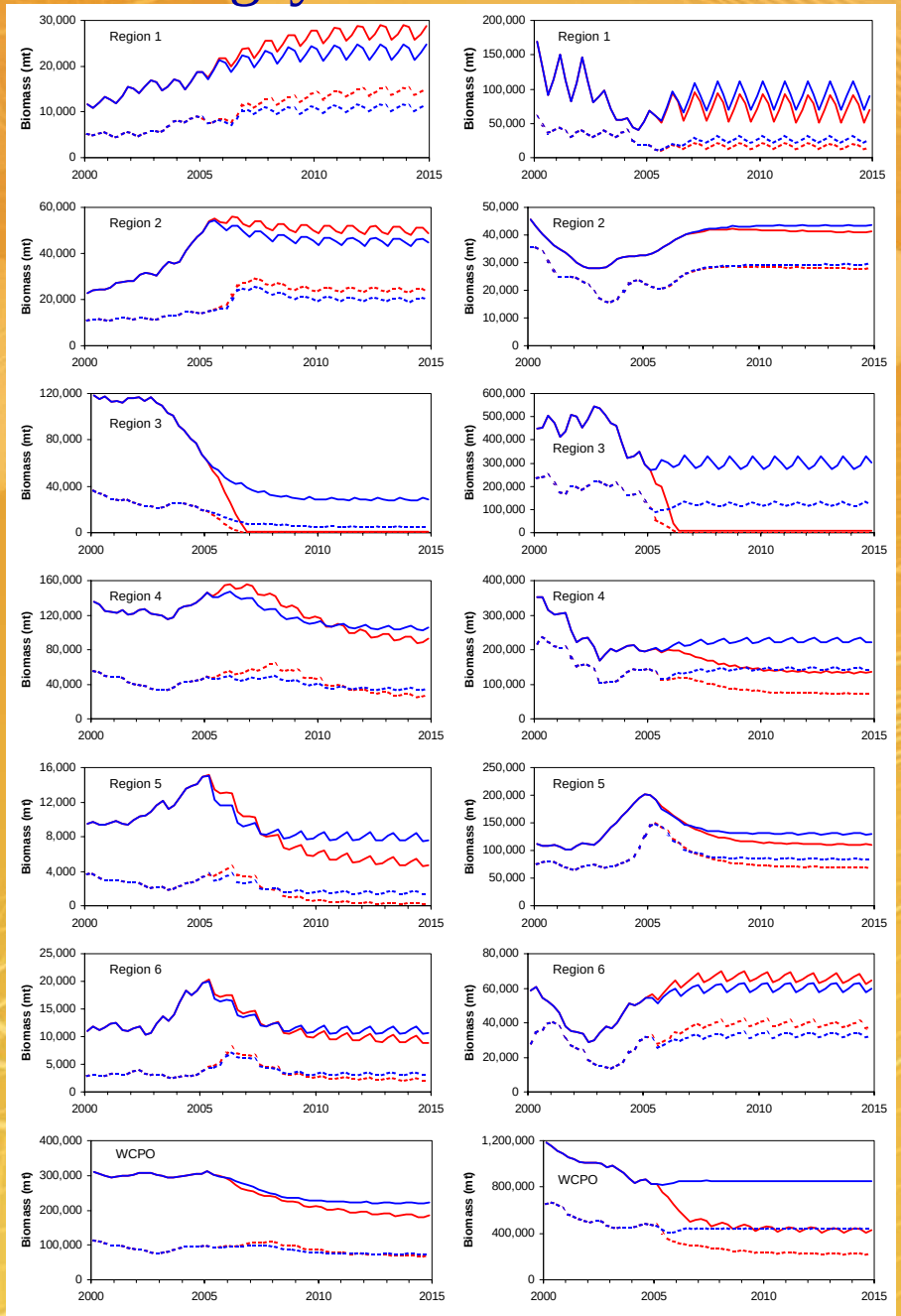
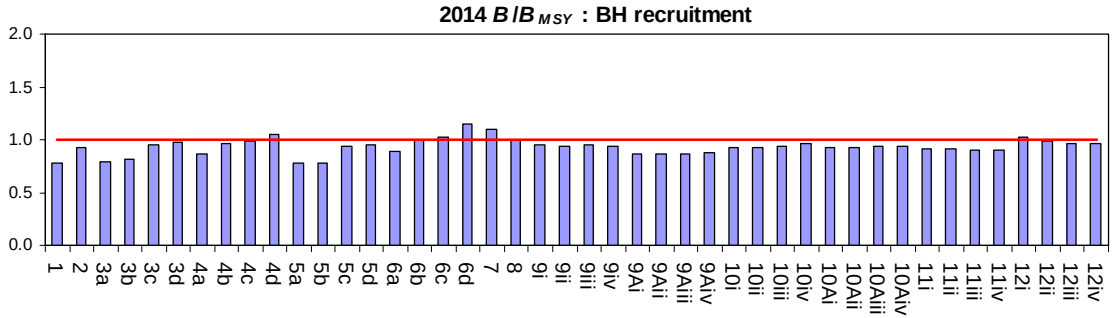
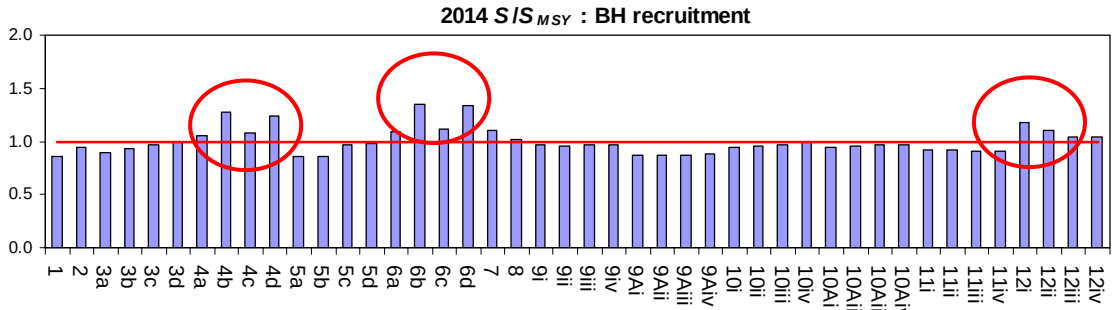
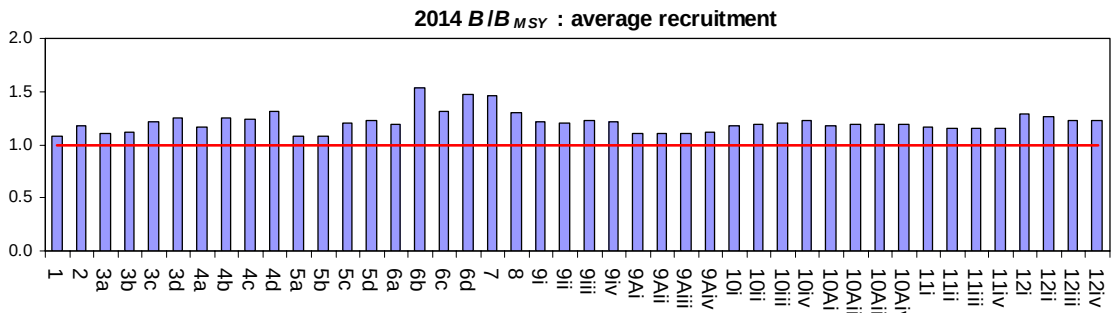
Projection Dynamics

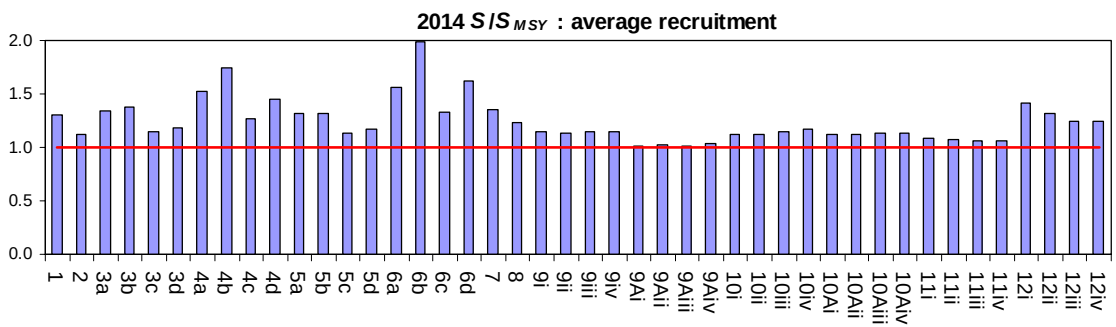


Comparing Projection Runs - Bigeye

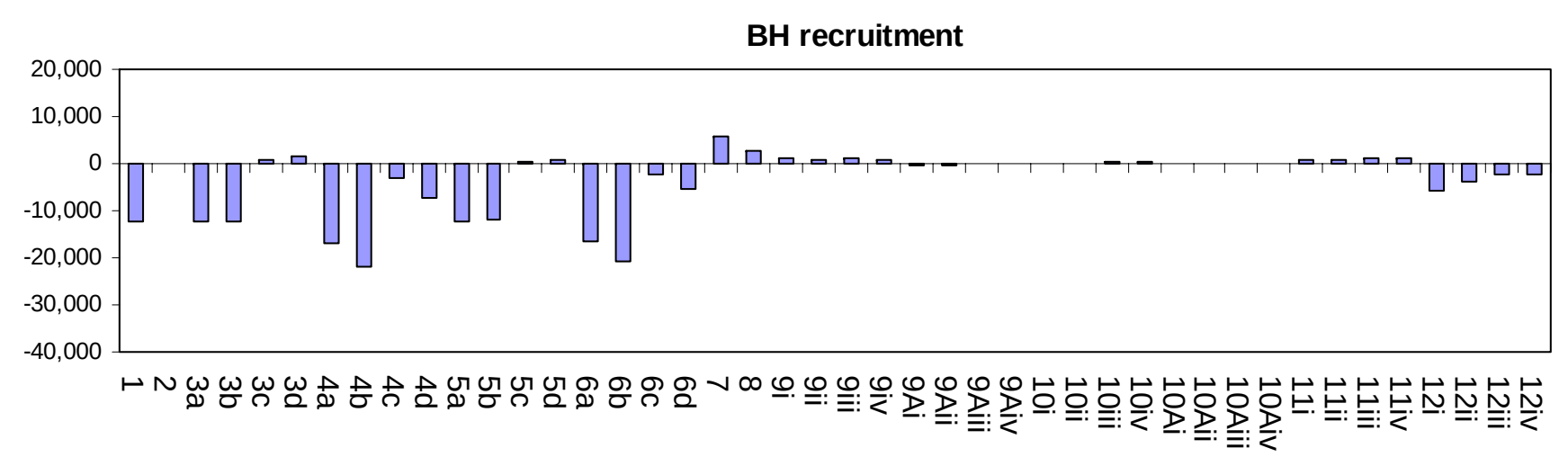


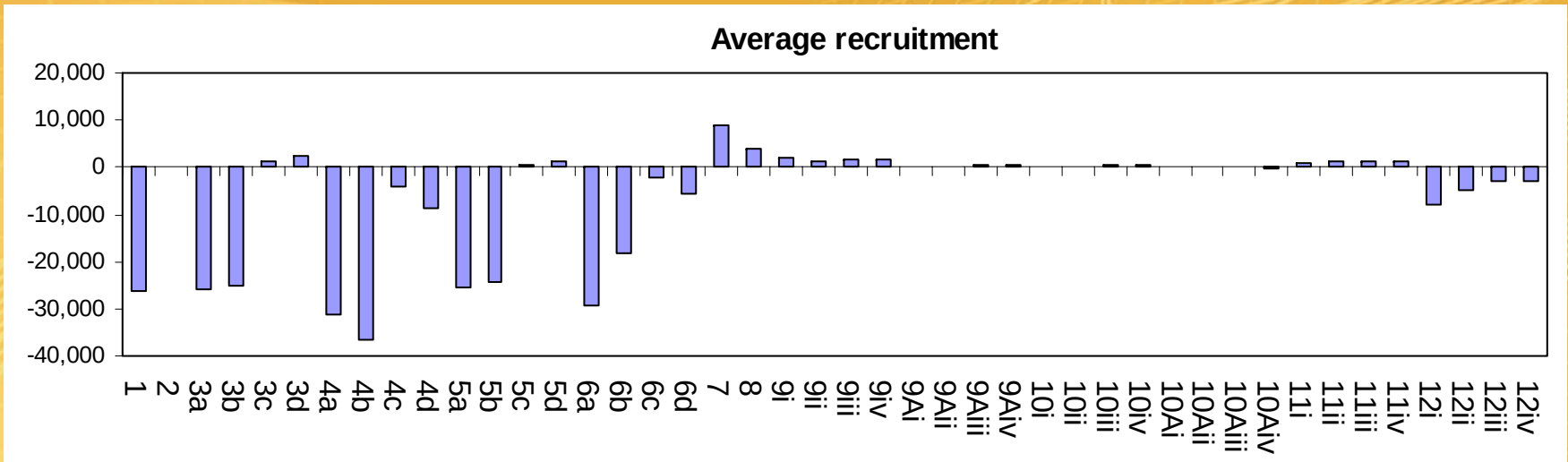




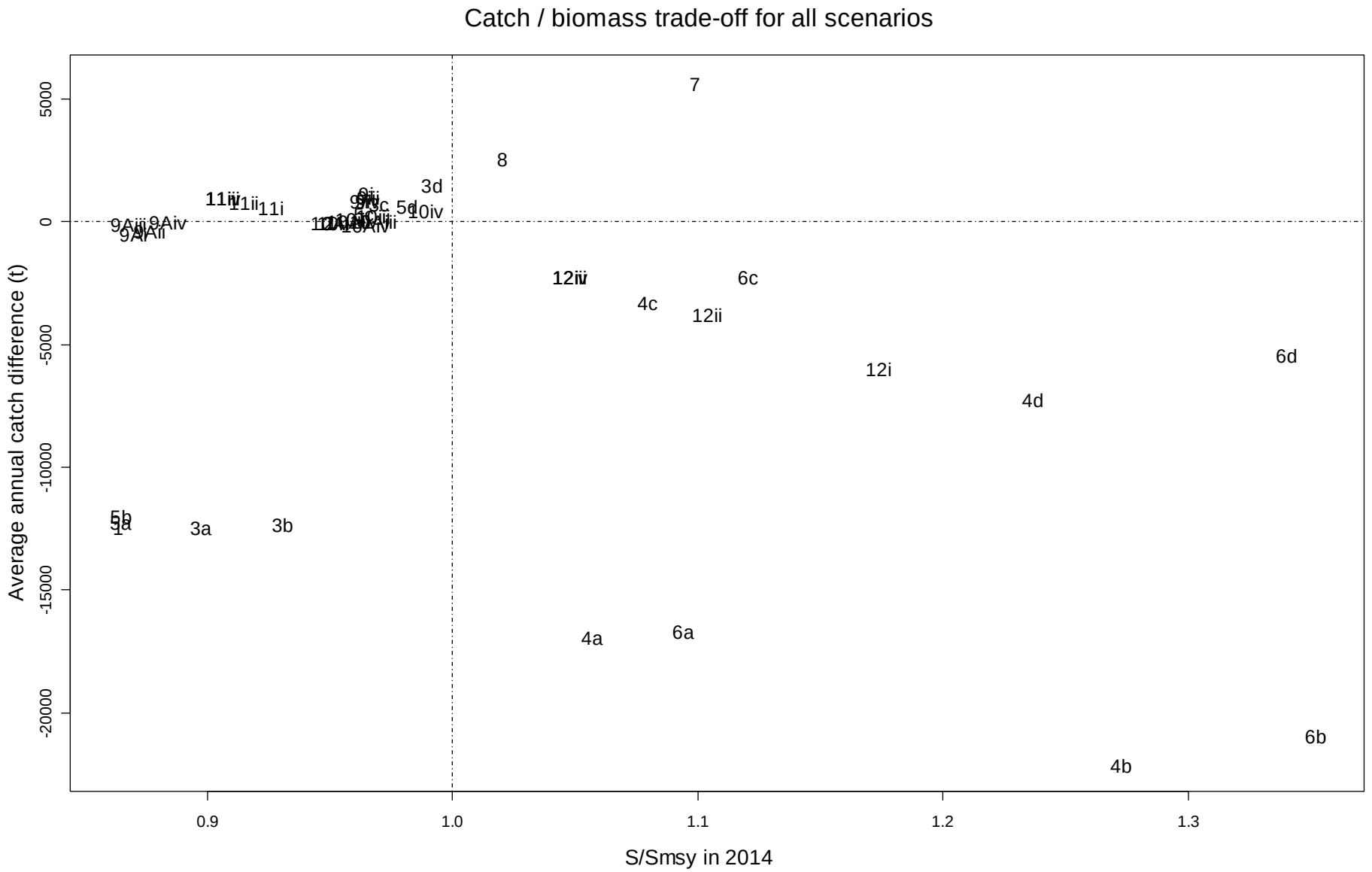


Fishery Impacts - Bigeye

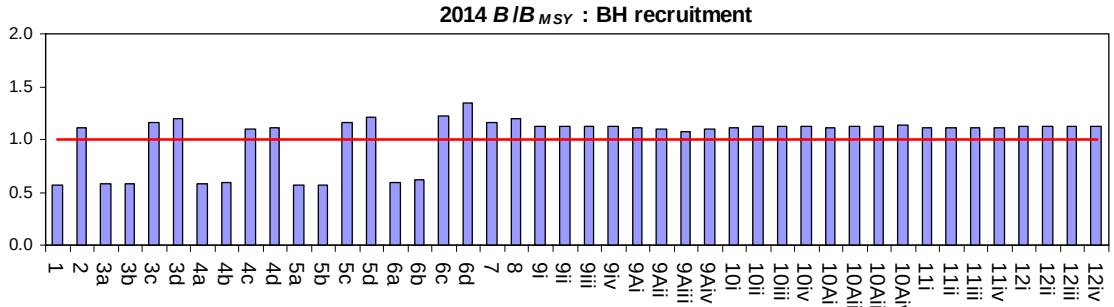


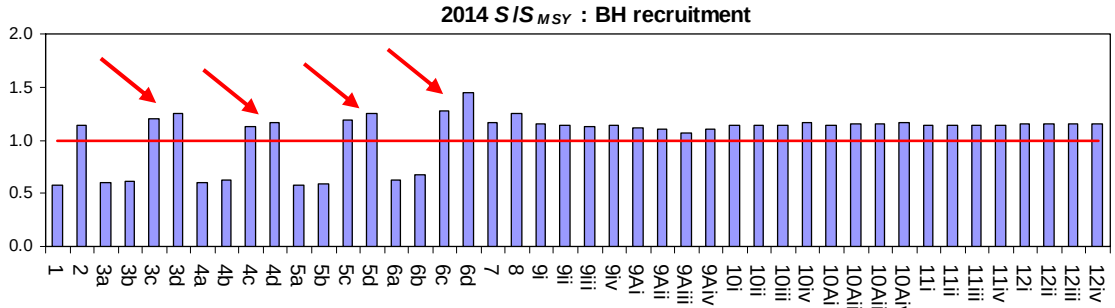


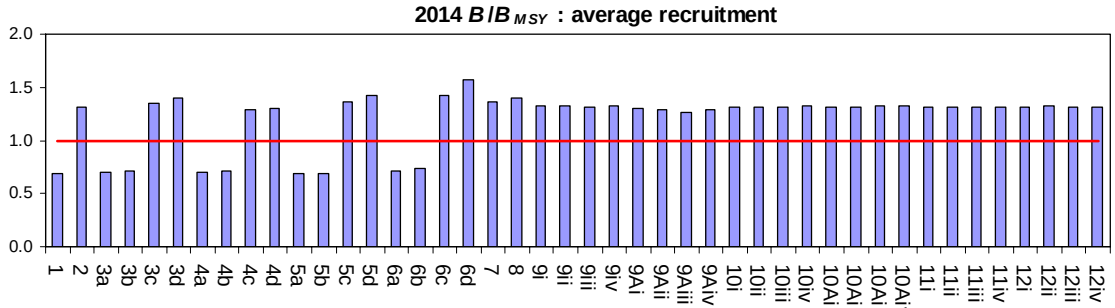
Biomass/Catch Tradeoffs - Bigeye

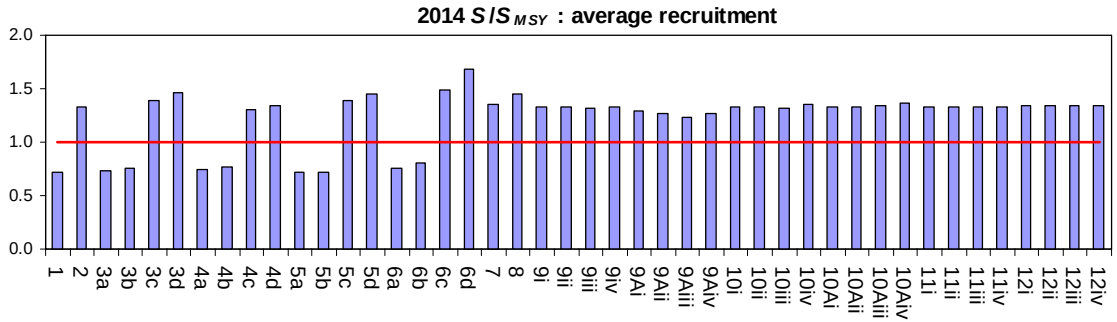


Comparing Projection Runs - Yellowfin

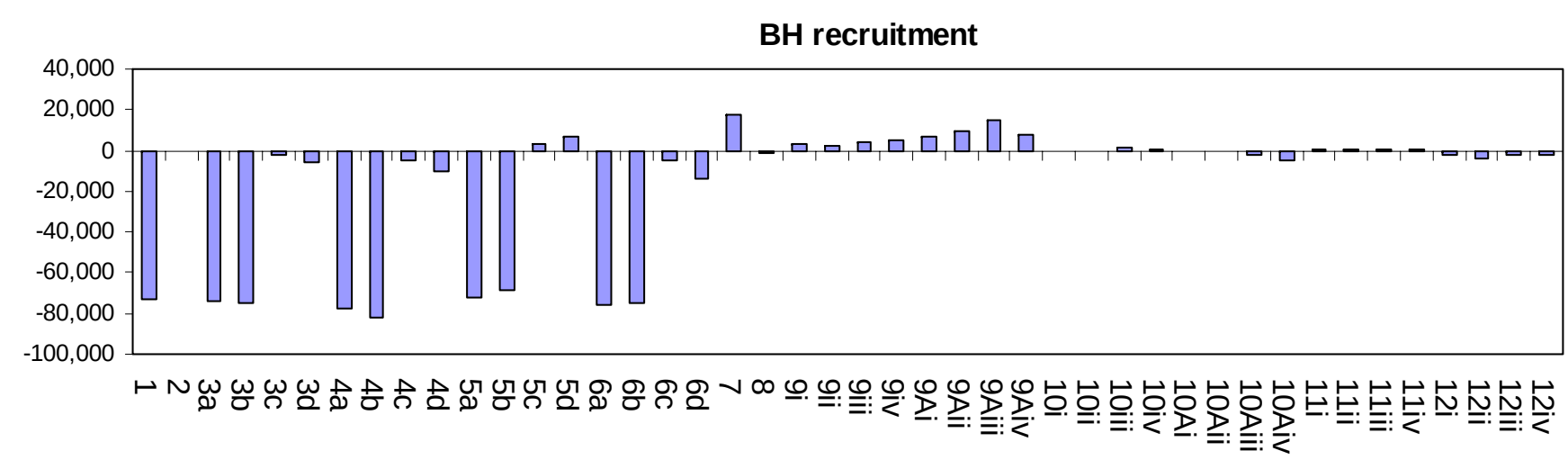


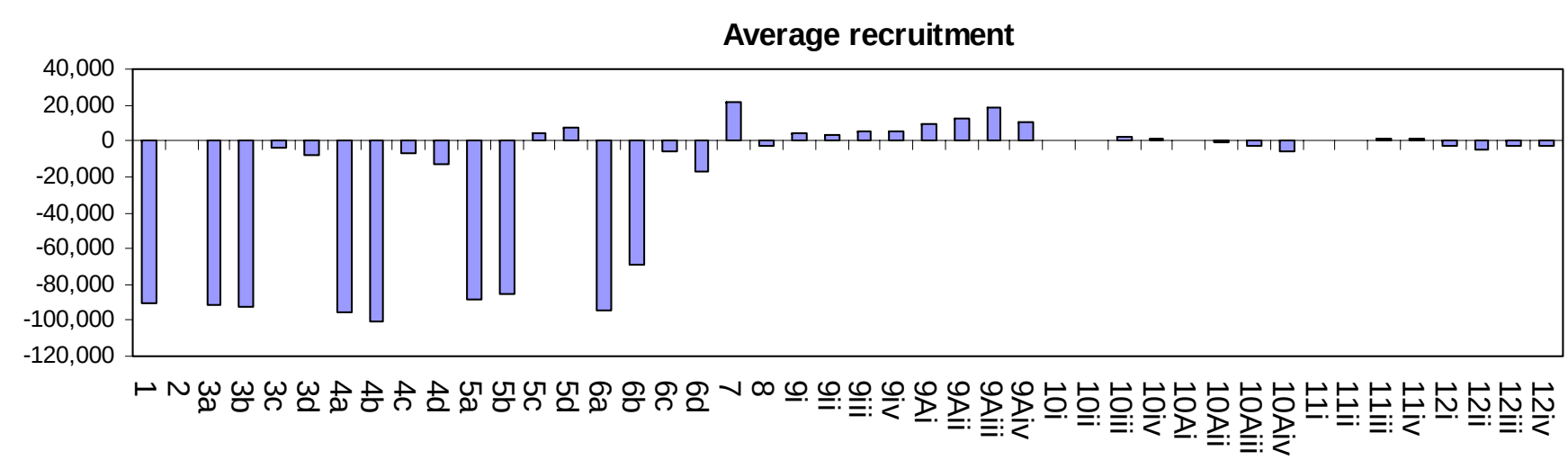




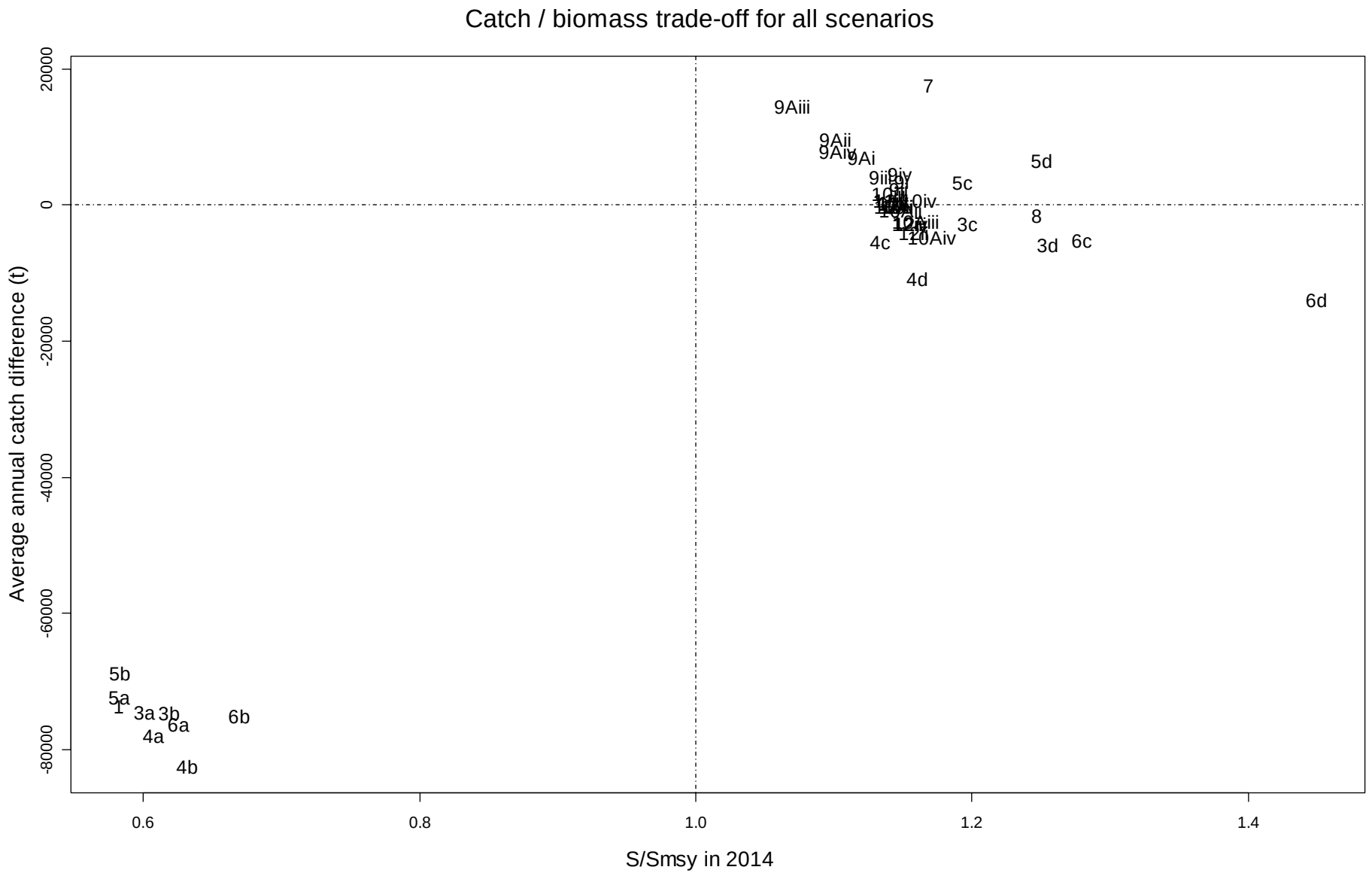


Fishery Impacts - Yellowfin





Biomass/Catch Tradeoffs - Yellowfin



Projection Conclusions

- Reductions in longline catch/effort have an immediate and significant impact on bigeye tuna adult biomass.
- Switching effort from log/FAD to unassociated school sets was the most effective purse seine measure investigated in the case of bigeye. For yellowfin, a simulated 50% reduction in log/FAD set catchability provided somewhat greater biomass gains.
- Quarterly closures in individual regions were not particularly effective when effort is allowed to transfer to the neighbouring region during the closure (the possible exception being longline closures in region 4 in the case of bigeye).
- A feature of the catch-based projections for both bigeye and yellowfin was the continued decline in abundance in region 3 towards zero.