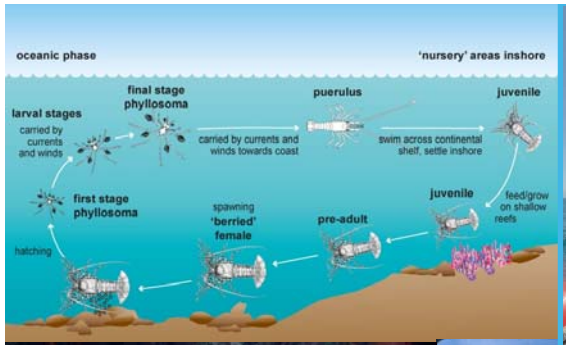
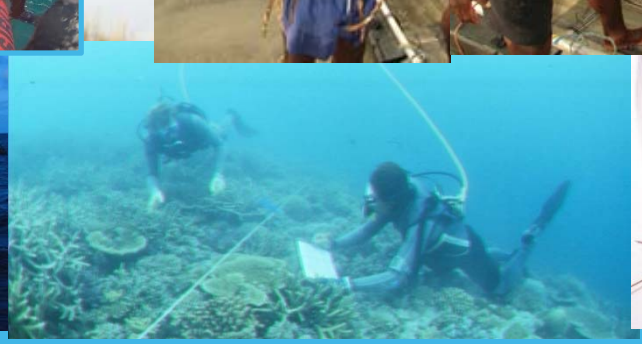




Risk equivalency tiered Harvest Strategy approach for the Torres Strait tropical rock lobster (TRL) fishery

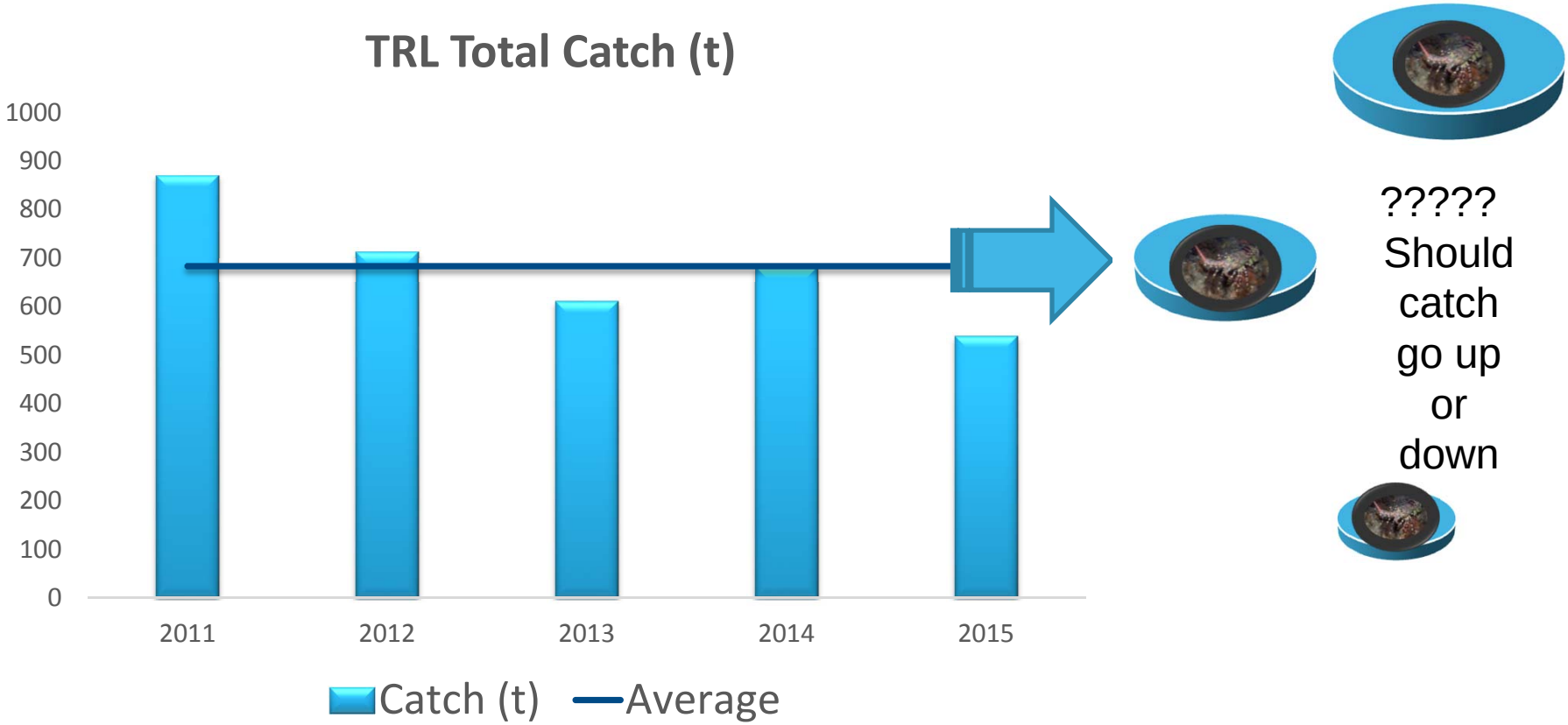
Éva Plaganyi, Roy Deng, Darren Dennis, Robert Campbell, Mick Haywood, Trevor Hutton, Mark Tonks

CSIRO Oceans and Atmosphere
www.csiro.au

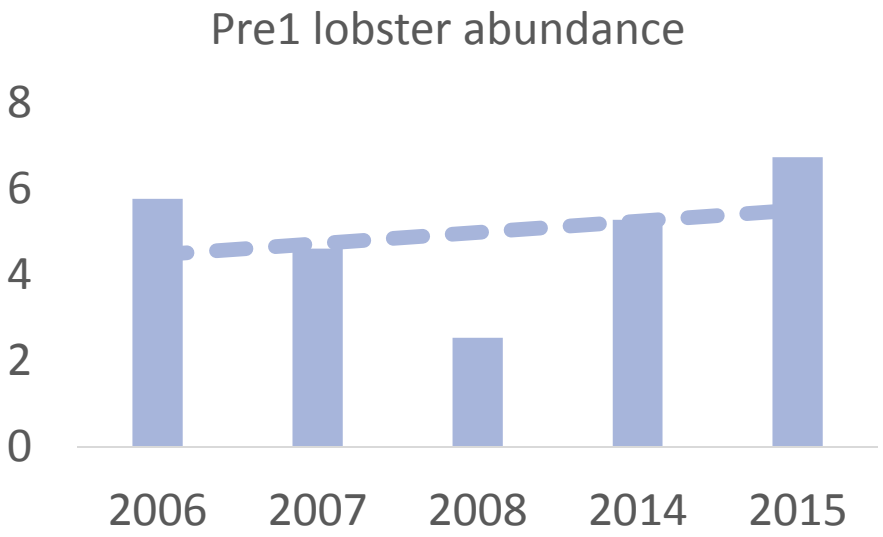
TRLRAG December 2016

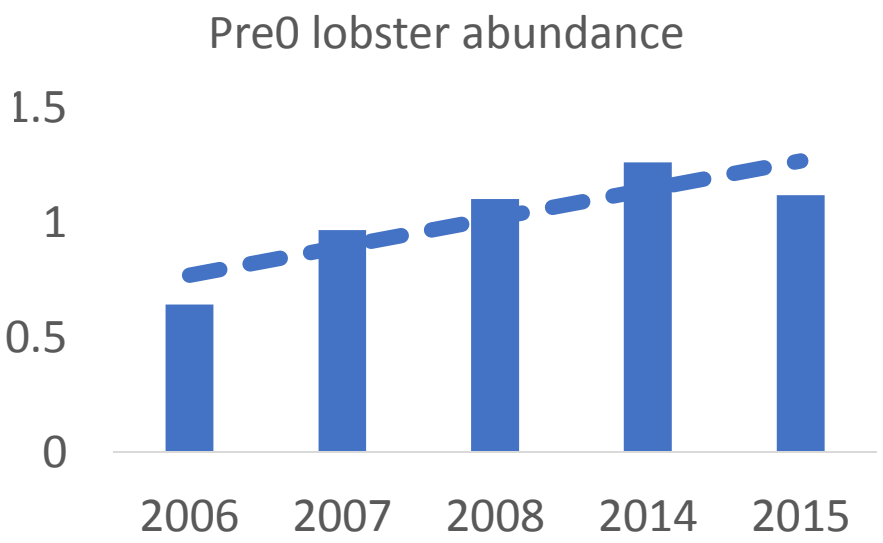
Australia's NATIONAL Harvest Strategy GUIDELINES
"FRAMEWORK specifies MANAGEMENT actions ... to achieve ecological, economic &/or social OBJECTIVES"
TORRES STRAIT TRL FISHERY
HARVEST control RULE (HCR)
CSIRO
example:
data
collected & analysed
tonnage
pre-test
TAC = HCR
average catch
3 years
STOCK ASSESSMENT
AFTER
FROM INDUSTRY:
Q. DISCARDS?
mortality needs recording
RAISE @
OPTIONS
WORKING GROUP
advantages
SOUND basis for setting TACs
addresses SCIENTIFIC uncertainty
quick to IMPLEMENT
can reduce COSTS doing annual assessment
transparent
QUICK to run
empirical HCR
INDICATORS
CPUE
MONITORING
HARVEST STRATEGY components
REFERENCE POINTS
Limit 32%
TARGET
AVOID
HARVEST DECISION RULES
CONTROL
METHOD of CPUE ASSESSMENT
A naturally variable FISHERY
SAFETY net
built into HCR
RBC = Recommended Biological Catch = combined AVERAGE slope indicators × AVERAGE catch
*maintain where we are and IF:
good YEAR
CATCH ↑
BAD YEAR
CATCH ↓
RBC never > 1000t
precautionary CHECK in RARE bad years
"run STOCK ASSESSMENT every 3 years
TRADITIONAL
MODEL analyses
"BEST ASSESSMENT"
Reference Point HCR
VS
HCR APPROACH
Formula recommends TAC
EMPIRICAL use data directly
Tested by SIMULATIONS
www.drsuepillans.com

Average catch and how to scale up or down

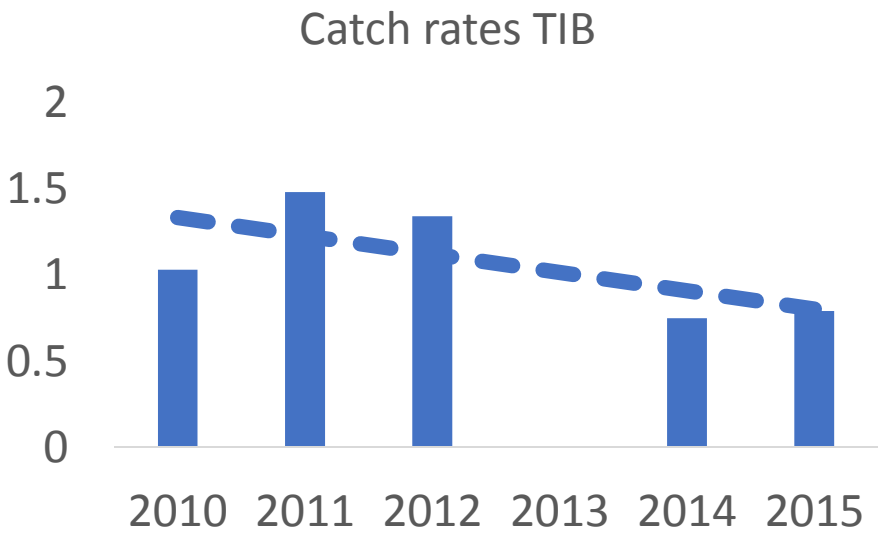


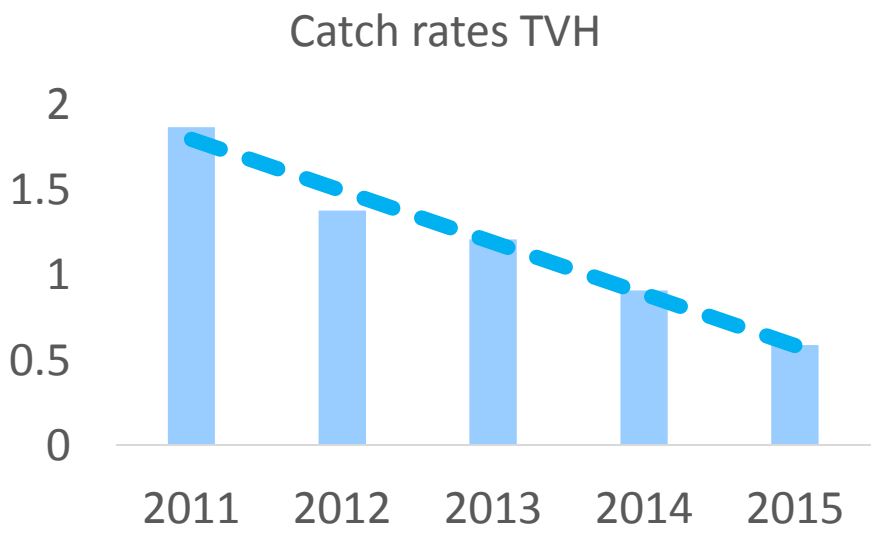
Indicators to tell us how many lobsters there will be next year: (A) Survey data





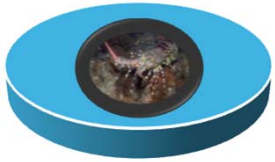
Indicators to tell us how many lobsters there will be next year: (B) CPUE data



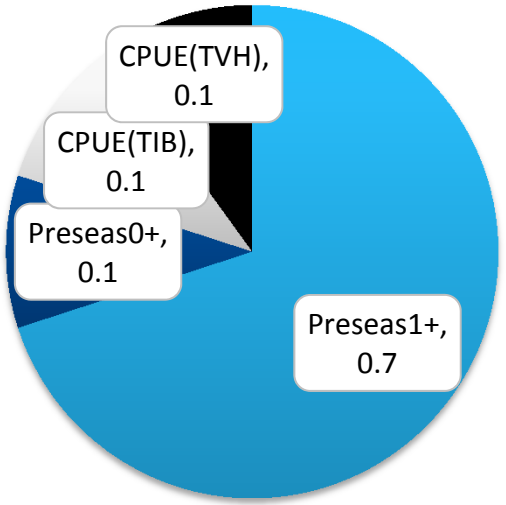


Use information from all 4 indicators

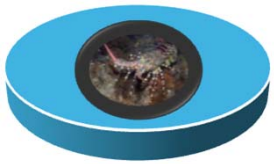
- Slopes all based on trend using last 5 years' data
- Use a mathematical trick (logs) to dampen trends to reduce very large changes in RBC



Relative weightings for different data inputs



eHCR Rule selected by the TRLRAG



RBC = Combined Average Slope of Indicators * Average Catch

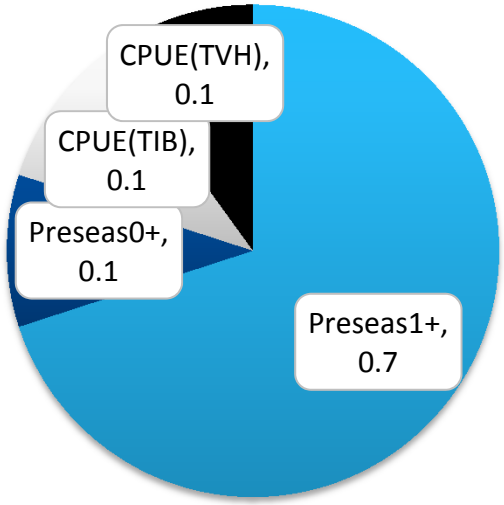
Ensure RBC is never greater than 1000t

Precautionary check in rare bad years: if Preseason 1+ index is very low then perform a stock assessment immediately

Check eHCR performing as expected by running a full stock assessment every 3 years

eHCR = Empirical Harvest Control Rule

Relative weightings for different data inputs



Torres Strait tropical lobster / Kaiar *Panulirus ornatus*

Harvest Control Rule Recommended Biological Catch Calculator

Australian Government
Australian Fisheries Management Authority

A. Instructions

> Cells shaded light yellow can receive entered values. Cells shaded light blue show results, but cannot be changed.

> Enter data updates in the yellow-shaded cells in Section B below. Example values have been entered for 2016. These need to be changed to the real values when these are available. Data will be provided annually.

> Total Catch to be entered = TIB+TVH+PNG catch in tons (live weight).

> Preseason survey indices = the standardised values obtained from the November survey; the last 5 values of each series need to be checked

> CPUE = the standardised values obtained from the analyses run in October; note that if the earlier values change in the standardisation, the last 5 values of each series all need to be updated for the calculations below.

> The resulting 2017 recommended biological catch (RBC) calculated using the Harvest Control Rule is shown in Section C, together with comparative values for the 2015 and 2016 HCR RBCs for comparison. Historical TACs and the 2017 RBC are plotted compared to the historical average TAC.
> Consolidated historical and entered data are summarised in Section D and the Survey and CPUE regressions through the recent data are plotted.
Further information on the HCR is provided in Section E.
(Spreadsheet by CSIRO, contact Dr Eva Plaganyi-lloyd: Eva.Plaganyi-lloyd@csiro.au)

B. Data Entry Section

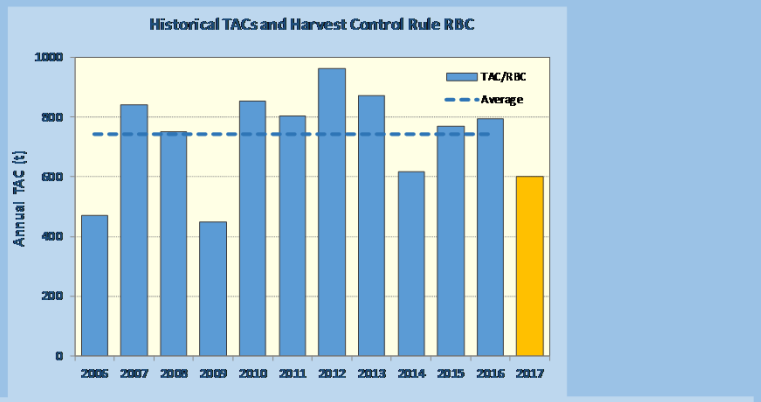
Year	Total Catch	Survey indices		CPUE indices	
		Preseason			
2015	562.3	0+	Preseason 1+	CPUE_TIB	CPUE_TVH
2016	571.8	1.18	2.80	1.21	1.01

ENTER UPDATED DATA HERE

C. RBC Calculator

Year	RBC	Forecast RBC		RBC-Forecast
2015	701.9	*585.7*		
2016	659.5	*587.3*		73.8
2017	**602.1**	*520.3*	HCR	14.9

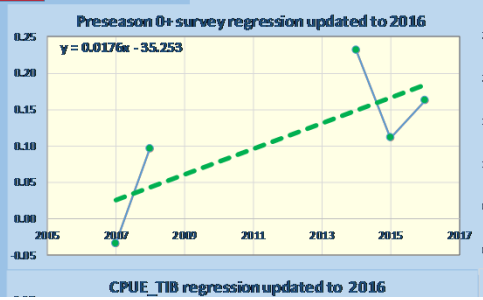
RBC (AUS AND PNG) CALCULATED FOR NEXT YEAR

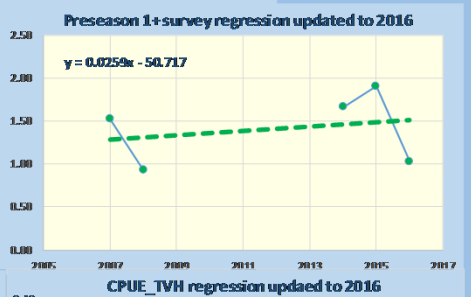


D. Consolidated Catch, Indices and RBCs table

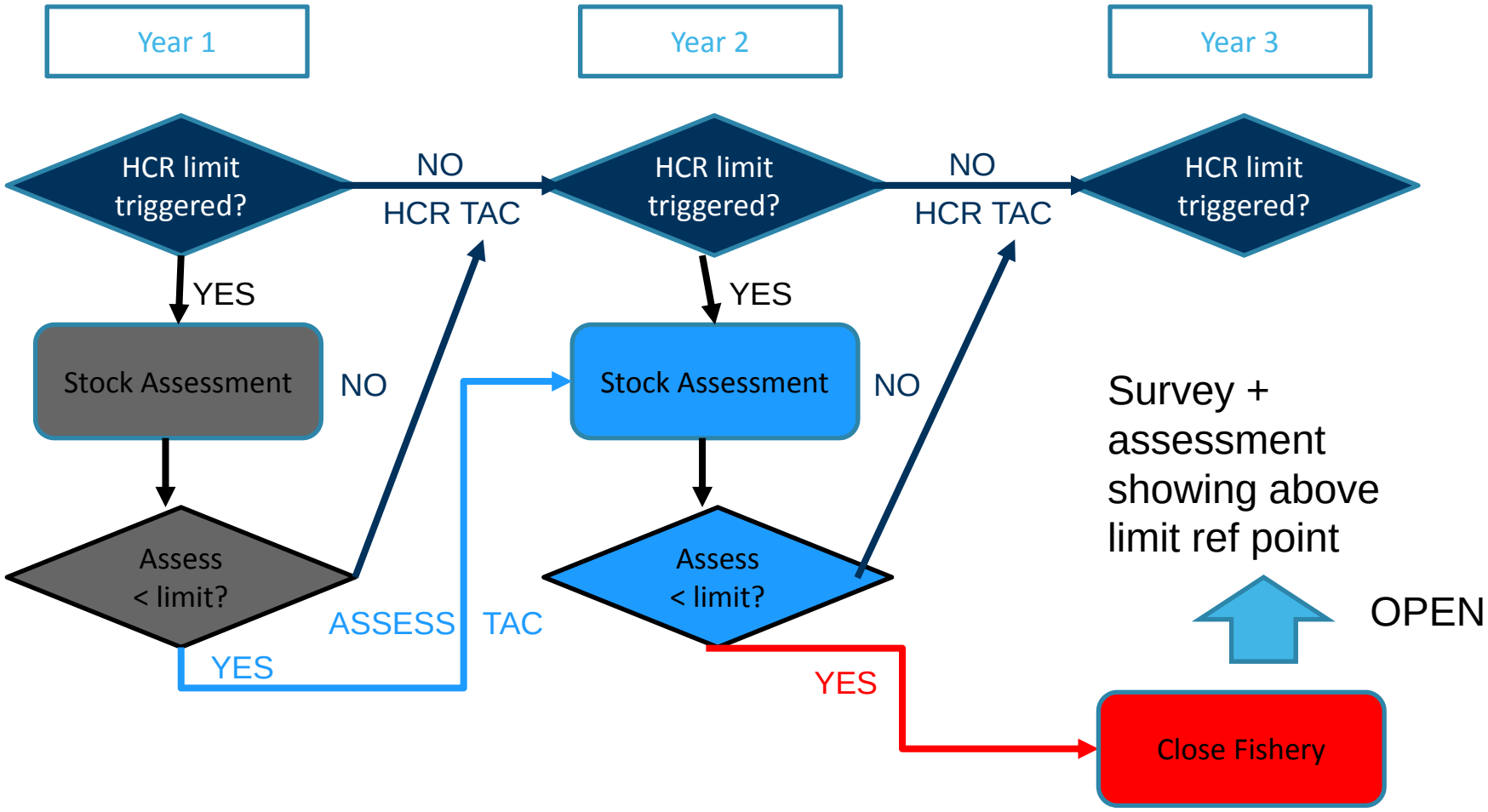
Seller+QA Int-1

Year	Total Catch	Survey indices		CPUE indices		TAC / RBC	Average TAC
		Preseason 0+	Preseason 1+	CPUE_TIB	CPUE_TVH		
2006	429.7	0.64	5.76	0.76	0.69	471	744
2007	756.6	0.97	4.60	0.86	0.96	842	744
2008	505.4	1.10	2.53	0.88	0.83	751	744
2009	388.4			0.89	0.63	450	744
2010	718.7			1.10	1.14	853	744
2011	869.2			1.33	1.75	803	744
2012	697			1.26	1.41	964	744
2013	604.2				1.17	871	744
2014	572.6	1.26	5.27	0.90	0.91	616	744
2015	**562.3**	1.12	6.72	0.86	0.58	769	744
2016	**571.8**	**1.18**	**2.80**	1.21	1.01	796	744
2017						**602**	





$$TAC_{y+1} = \left[0.7 \cdot \left(1 + s_y^{presurv,1}\right) + 0.1 \cdot \left[\left(1 + s_y^{presurv,0}\right) + \left(1 + s_y^{CPUE,TVH}\right) + \left(1 + s_y^{CPUE,TIB}\right)\right]\right] \cdot \bar{C}_{y-4,y}$$


Year 1
Year 2
Year 3
HCR limit triggered?
NO
HCR TAC
HCR limit triggered?
NO
HCR TAC
HCR limit triggered?
YES
YES
Stock Assessment
NO
Stock Assessment
NO
Survey + assessment showing above limit ref point
Assess < limit?
ASSESS TAC
YES
Assess < limit?
YES
OPEN
Close Fishery

Risk Equivalency

- The amount and quality of data and surveys available to inform assessments of the Torres Strait tropical rock lobster (TRL) stock has varied over time, and stakeholders have requested flexibility to increase or decrease the frequency and intensity of fishery-independent surveys in future.
- As monitoring, management and costs increase for a fishery, the risk associated with being overfished declines
- Risk =probability of a resource falling below the limit reference point; related to the stock's productivity and amount of catch
- HSP defines risk equivalency based on the criterion that the stock stays above the limit biomass level at least 90% of the time
- The trade-offs between managing a fishery in a biologically and economically optimal way whilst minimising management costs is referred to as the risk-cost-catch frontier

Risk-cost-catch framework

High risk = need for precautionary management = lower fishery catches

Low risk = less need for precautionary management = higher fishery catches

LESS DATA

MORE DATA

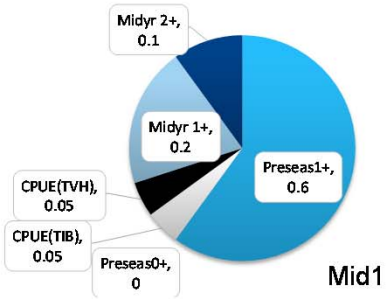
Harvest Control Rules: towards tiers and risk equivalency

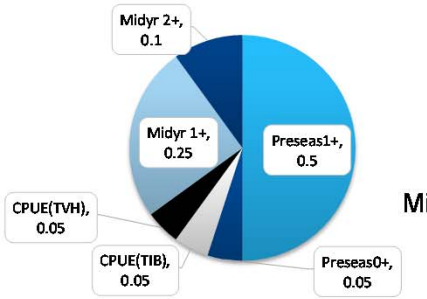
- Tier 1 (Bonus Tier): Monitoring information: Total catch (TIB, TVH,PNG), Midyear survey (1+ and 2+ relative abundance), Preseason survey (0+, 1+ relative abundance), CPUE standardised indices of abundance from TIB and TVH sectors (2+ index).
- **Tier 2 (Current Tier): Monitoring information: Total catch (TIB, TVH,PNG), Preseason survey (0+, 1+ relative abundance), CPUE standardised indices of abundance from TIB and TVH sectors (2+ index).**
- Tier 3 (Penalty Tier): Monitoring information: Total catch (TIB, TVH,PNG), CPUE standardised indices of abundance from TIB and TVH sectors (2+ index).
- Tier 4 (Lowest Tier): No monitoring information

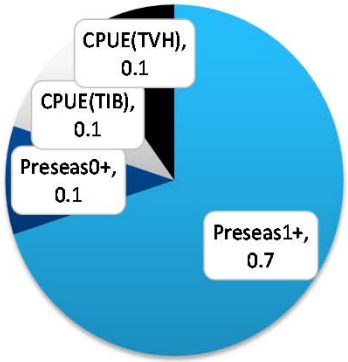
Tier 1

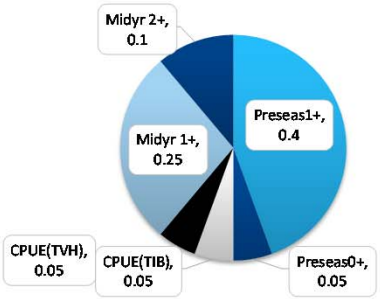
Tier 2

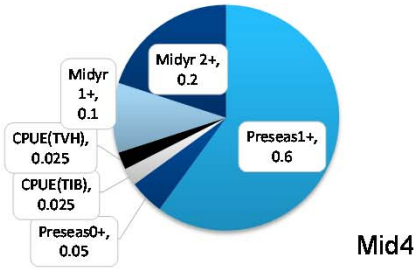
Range of alternative weightings tested



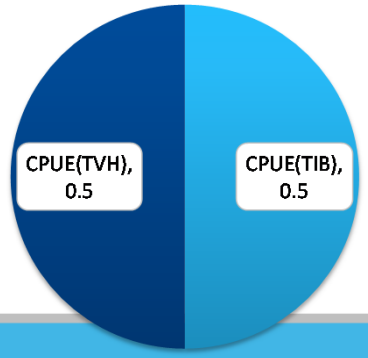






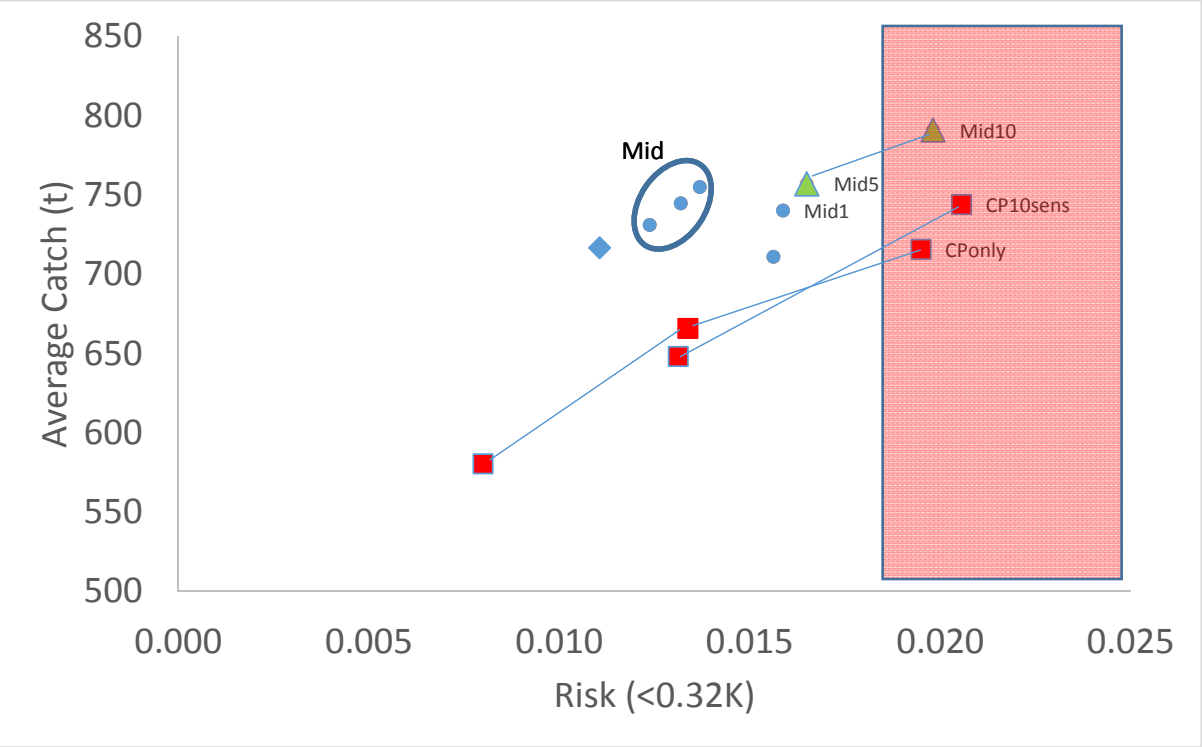


Tier 3



Tier 4: RBC = 360 t

Risk Equivalency Example

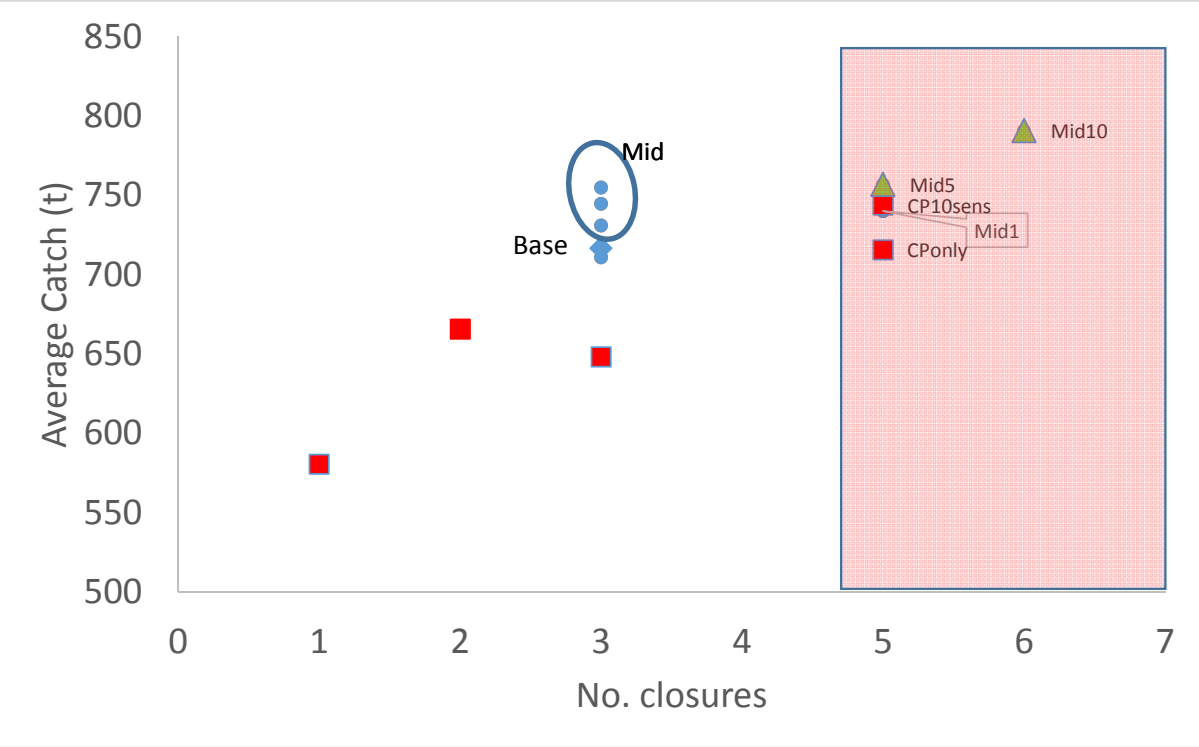


Higher risk with only CPUE especially if accounting for additional uncertainties – suggests penalty discount factor of ca. -20%

Higher catch for similar risk with extra survey – suggests bonus discount factor of ca. -5% (average +50t)

MSE testing accounts for observation error, implementation error (different for 3 fishery sectors), some model structural uncertainty (4 operating models)

Risk Equivalency Example



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Higher catch for similar risk with extra survey

MSE testing accounts for observation error, implementation error (different for 3 fishery sectors), some model structural uncertainty (4 operating models)

Harvest Control Rules: towards tiers and risk equivalency

Tier level	Information requirements	eHCR	Penalty or bonus discount factor applied to RBC
1	Catch, Midyear survey, Preseason survey, CPUE_TIB, CPUE_TVH	Based on all indices with weightings and rule as specified in App. 2.	5%
2	Catch, Preseason survey, CPUE_TIB, CPUE_TVH	Based on all indices with weightings and rule as specified in App. 1.	-
3	Catch, CPUE_TIB, CPUE_TVH	Based on CPUE indices and average catch as specified in App. 3.	-20%
4	Only for assessment	Fixed catch = 360t	-

$$TAC_{y+1} = \left[\begin{array}{l} w_1 \cdot \left(1+s_y^{presurv,1}\right) + w_2 \left(1+s_y^{presurv,0}\right) + w_3 \left(1+s_y^{CPUE,TVH}\right) + w_4 \left(1+s_y^{CPUE,TIB}\right) \\ +w_5 \left(1+s_y^{Midsurv,1}\right) + w_6 \left(1+s_y^{Midsurv,2}\right) \end{array} \right] \cdot \bar{C}_{y-4,y}$$

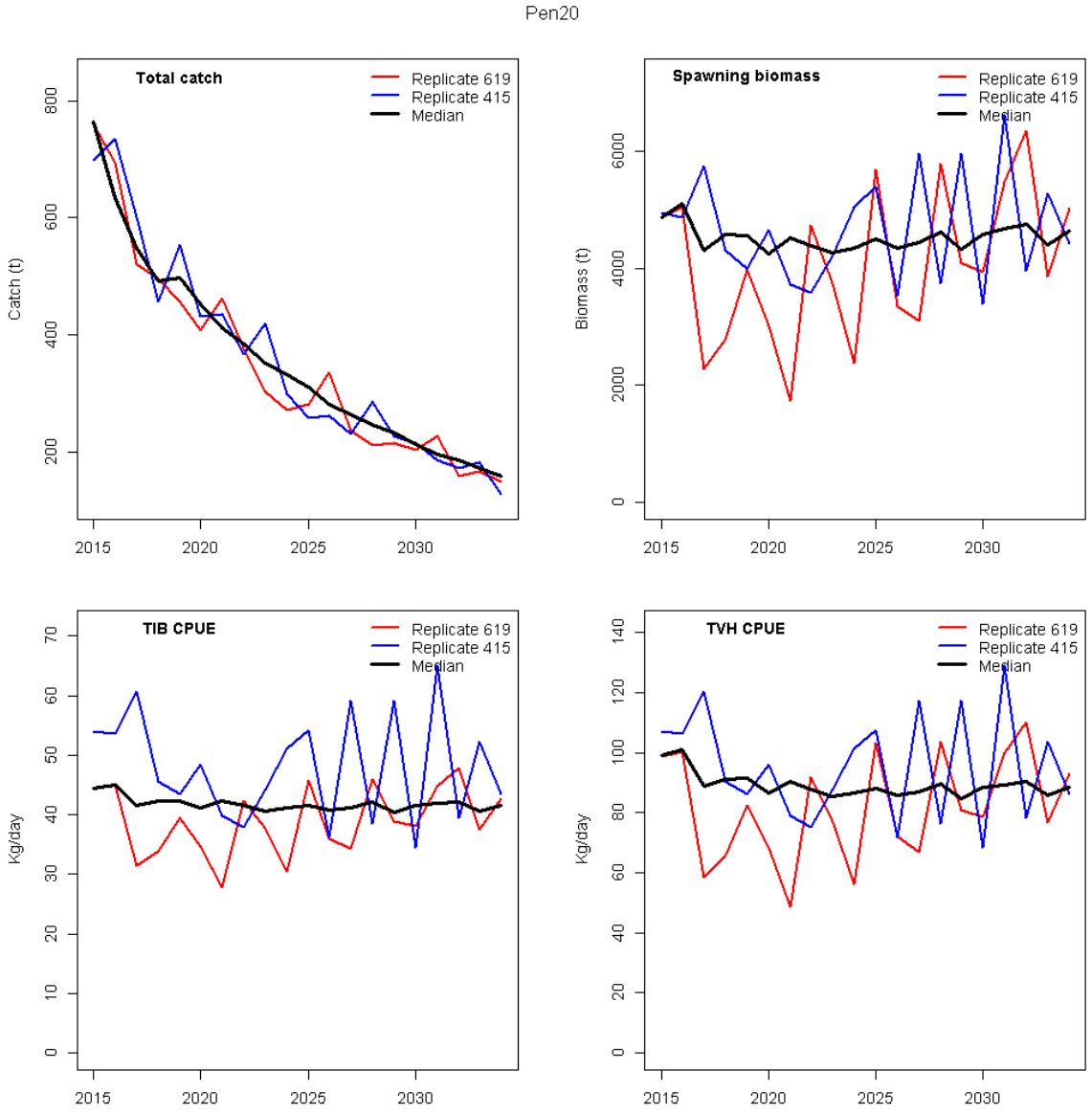
Bsp<0.32K
Relative frequency
0.00
0.02
0.04
0.06
0.08
0.10
0.12
FinalPre
SensFinal_800
Mid1
Mid2
Mid3
Mid4
Mid5
Mid10
NoSurv
Pen20_5yr
Pen20
Pen33
Pen50
CPonly
CP10sens
CP10
CP20sens
CP20

AAV catch
Relative frequency
0.05
0.10
0.15
0.20
FinalPre
SensFinal_800
Mid1
Mid2
Mid3
Mid4
Mid5
Mid10
NoSurv
Pen20_5yr
Pen20
Pen33
Pen50
CPonly
CP10sens
CP10
CP20sens
CP20

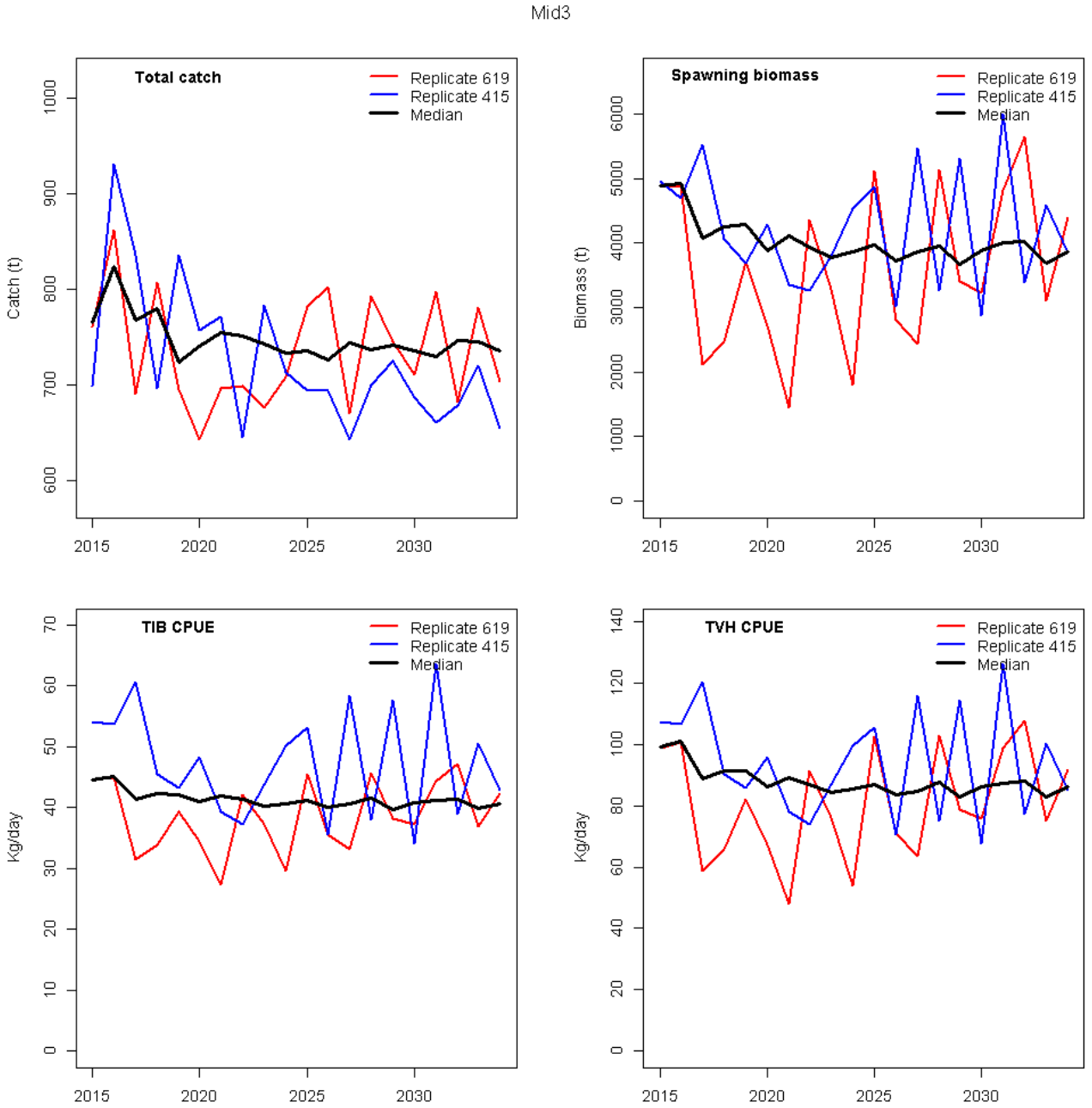
N_closure
Number of closure
0
1
2
3
4
5
6
FinalPre
SensFinal_800
Mid1
Mid2
Mid3
Mid4
Mid5
Mid10
NoSurv
Pen20_5yr
Pen20
Pen33
Pen50
CPonly
CP10sens
CP10
CP20sens
CP20

Avg catch
Catch (ton)
200
400
600
800
FinalPre
SensFinal_800
Mid1
Mid2
Mid3
Mid4
Mid5
Mid10
NoSurv
Pen20_5yr
Pen20
Pen33
Pen50
CPonly
CP10sens
CP10
CP20sens
CP20

CPUE only – penalty and average catch rule



Mid3


Mid3
Total catch
Replicate 619
Replicate 415
Median
Catch (t)
600
700
800
900
1000
2015
2020
2025
2030
Spawning biomass
Replicate 619
Replicate 415
Median
Biomass (t)
0
1000
2000
3000
4000
5000
6000
2015
2020
2025
2030
TIB CPUE
Replicate 619
Replicate 415
Median
Kg/day
0
10
20
30
40
50
60
70
2015
2020
2025
2030
TVH CPUE
Replicate 619
Replicate 415
Median
Kg/day
0
20
40
60
80
100
120
140
2015
2020
2025
2030

Thank you

Oceans and Atmosphere
Dr Éva Pláganyi
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Brisbane, Australia

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Rob Campbell
Roy Deng
Mick Haywood
Trevor Hutton
Mark Tonks
Kinam Salee
Nicole Murphy

Addendum – correction to 2014 catch

Year	TiB	TVH	PNG	TS_Total	Aus_TAC	Catch as % of TAC
2004	235.1	481.0	182.0	898.1		
2005	358.5	545.0	228.0	1131.5		
2006	152.3	135.4	142.0	429.7	471	91%
2007	260.0	268.6	228.0	756.6	842	90%
2008	183.9	100.4	221.0	505.4	751	67%
2009	135.9	91.1	161.4	388.4	450	86%
2010	143.3	282.6	292.8	718.7	853	84%
2011	200.7	503.5	165.0	869.2	803	108%
2012	152.9	370.5	173.7	697.0	964	72%
2013	134.2	361.7	108.3	604.2	871	69%
2014	148.5	272.7	261.2	682.4	616	111%
2015	173.9	152.7	235.7	562.3	769	73%
2016	207.1	237.6	127.1	571.8	796	72%

Revised HCR spreadsheet

Torres Strait tropical lobster / Kaiar *Panulirus ornatus*

Harvest Control Rule Recommended Biological Catch Calculator

Australian Government
Australian Fisheries Management Authority

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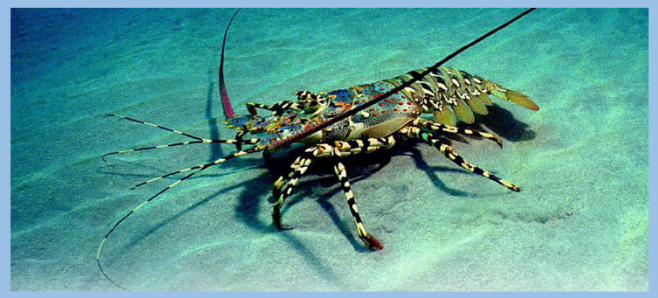

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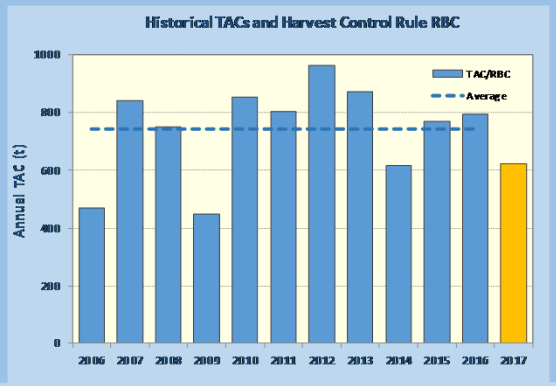
		Preseason			
		0+	Preseason 1+	CPUE_TIB	CPUE_TVH
2015	562.3				
2016	**571.8**	**1.18**	**2.80**	**1.21**	**1.01**

ENTER UPDATED DATA HERE



C. RBC Calculator

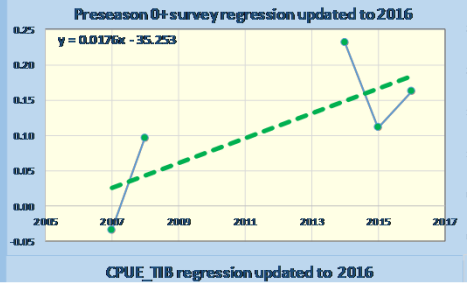
Year	RBC	Forecast RBC		RBC-Forecast
2015	724.2	*604.3*		
2016	681.4	*606.8*		77.1
2017	**624.1**	*539.3*	HCR	17.3

RBC (AUS AND PNG) CALCULATED FOR NEXT YEAR

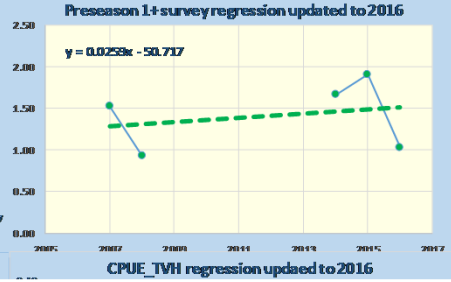
D. Consolidated Catch, Indices and RBCs table

Seller+QA Int-1

Year	Total Catch	Survey indices		CPUE indices		TAC / RBC	Average TAC
		Preseason 0+	Preseason 1+	CPUE_TIB	CPUE_TVH		
2006	429.7	0.64	5.76	0.76	0.69	471	744
2007	756.6	0.97	4.60	0.86	0.96	842	744
2008	505.4	1.10	2.53	0.88	0.83	751	744
2009	388.4			0.89	0.63	450	744
2010	718.7			1.10	1.14	853	744
2011	869.2			1.33	1.75	803	744
2012	697			1.26	1.41	964	744
2013	604.2				1.17	871	744
2014	682.4	1.26	5.27	0.90	0.91	616	744
2015	562.3	1.12	6.72	0.86	0.58	769	744
2016	**571.8**	**1.18**	**2.80**	1.21	1.01	796	744
2017						**624**	



CPUE_TIB regression updated to 2016



CPUE_TVH regression updaed to 2016