

BioRA Preparation Meeting PART I
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Overview of interpretation of Fisheries outputs of BioRA



- ⇒ Refresher on indicators and response curves
- ⇒ Calibration scenarios
- ⇒ Predicted change in fish indicators

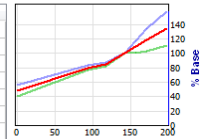
BioRA ecosystem indicators showing applicable FAs

Indicator Groups	Focus Areas							
	1	2	3	4	5	6	7	8
Rithron resident species								
Main channel resident (long distant white) species								
Main channel spawner (short distance white) species								
Floodplain spawner (grey) species								
Eurytopic (generalist) species								
Floodplain resident (black)								
Estuarine resident species								
Anadromous species								
Catadromous species								
Marine visitor species								
Non-native species								
Composite: Fish biomass								

Response curves: Main channel resident - migrating whitefish species

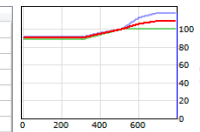
Wet duration [F season]

Desc	days	Y1	Y2
Min	0.000	-3.000	
Min Base	93.000	-1.158	
Median	142.500	0.000	
Max Base	172.000	1.268	
Max	197.800	1.787	



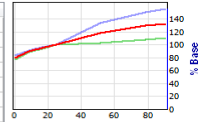
FA2 Wet: ave Sediment conc [F season]

Desc	ppm	Y1	Y2
Min	0.000	-0.579	
Min Base	302.062	-0.579	
Median	509.098	0.000	
Max Base	596.768	0.300	
Max	787.104	0.624	



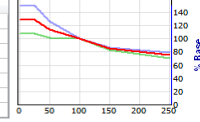
Dry max rate of change [D season]

Desc	m3/s/min	Y1	Y2
Min	0.000	-1.158	
Min Base	8.343	-0.579	
Median	16.393	-0.289	
Max Base	51.569	1.268	
Max	78.695	1.644	



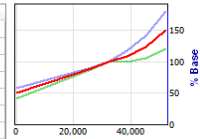
Erosion (bank / bed incision) [F season]

Desc	%Base	Y1	Y2
Min	0.000	1.644	
Min Base	25.000	1.644	
Median	50.000	1.001	
Max Base	150.000	-0.868	
Max	200.000	-1.158	



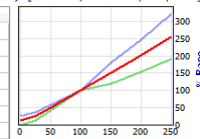
Wet: ave FloodVolumeFA6 [F season, Site=FA6]

Desc	m/km	Y1	Y2
Min	0.000	-2.895	
Min Base	20194.460	-1.158	
Median	26142.756	-0.579	
Max Base	32091.053	0.000	
Max	38752.174	0.628	



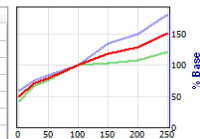
Main channel resident (long distance white) [F season, Site=FA4, Step= -1]

Desc	%Base	Y1	Y2
Min	0.000	-5.000	
Min Base	25.000	-4.300	
Median	50.000	-2.900	
Max Base	150.000	2.100	
Max	200.000	2.700	



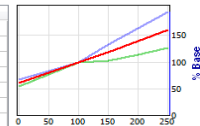
Zooplankton abundance [F season]

Desc	%Base	Y1	Y2
Min	0.000	-2.895	
Min Base	25.000	-1.737	
Median	50.000	-1.158	
Max Base	150.000	1.268	
Max	200.000	1.644	

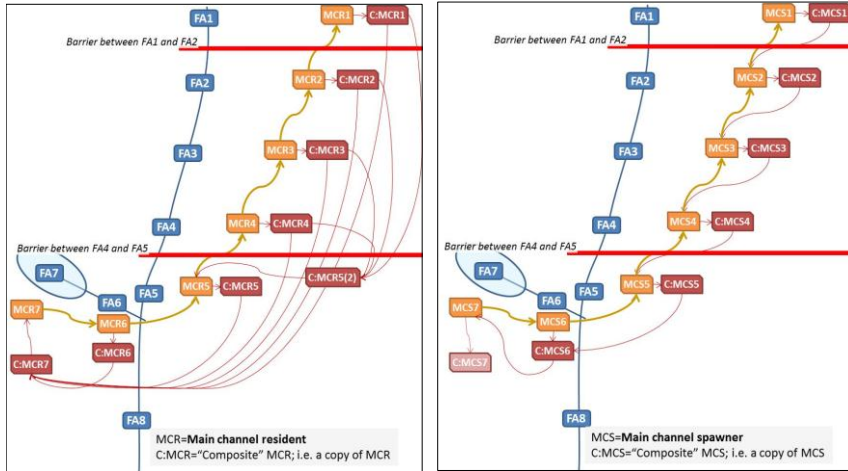


Conn: Fish from tributaries [F season]

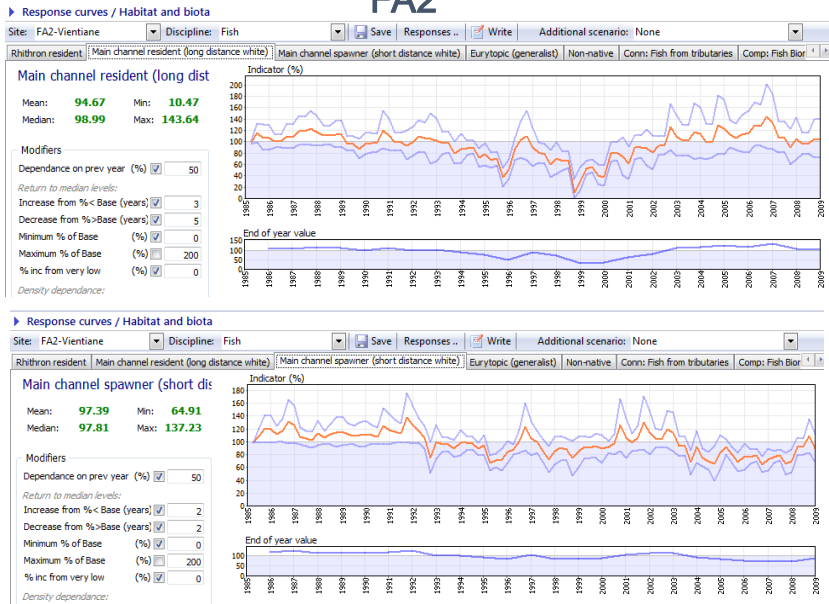
Desc	%Base	Y1	Y2
Min	0.000	-2.258	
Min Base	25.000	-1.693	
Median	50.000	-1.129	
Max Base	150.000	1.245	
Max	200.000	1.888	



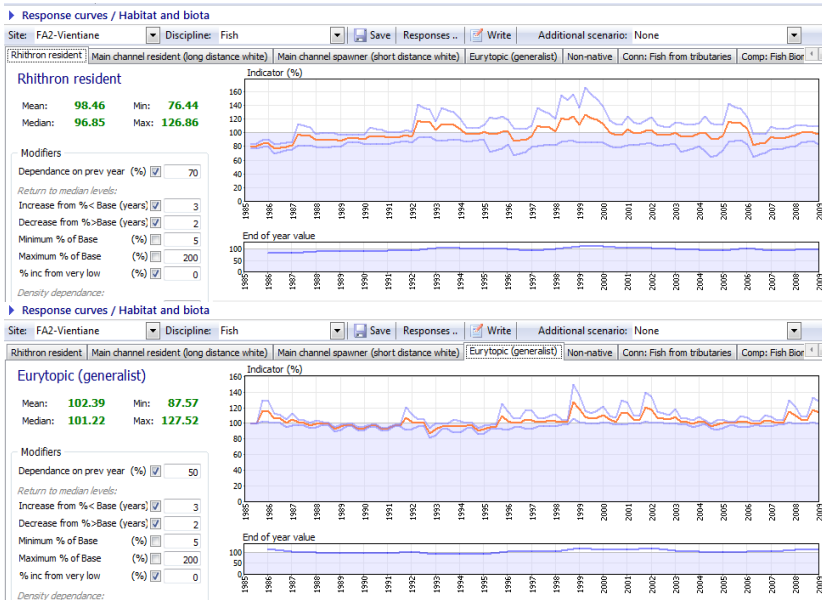
Connectivity



Response curves: Main channel resident - migrating whitefish species FA2



Response curves: Rhithron and Eurytopic species FA2



Calibration Scenarios

CS 1: High dry season flow, low wet season flow

CS 2: 6 dry years, followed by 6 wet years, etc.

CS 3: A shortened wet season

CS 4: Sediment supply at 75% of Preliminary Reference

CS 5: Migration blocked between FA1 and FA2 ONLY

CS 6: not used

CS 7: Extreme dry year (1992 – 10%) repeated for whole sequence

CS 8: Migration blocked between FA4 and 5 ONLY

CS 9: Migration blocked between FA1 and 2 AND between FA4 and 5

CS 10: Sediment supply at 25% of Preliminary Reference

Calibration Scenarios

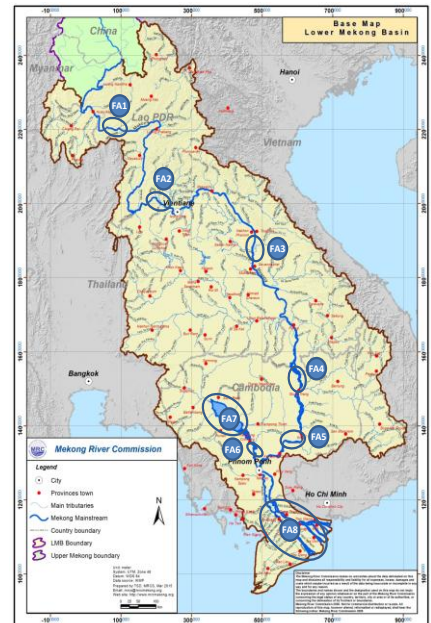
CS 5: Migration blocked between FA1 and FA2 ONLY

CS 8: Migration blocked between FA4 and 5 ONLY

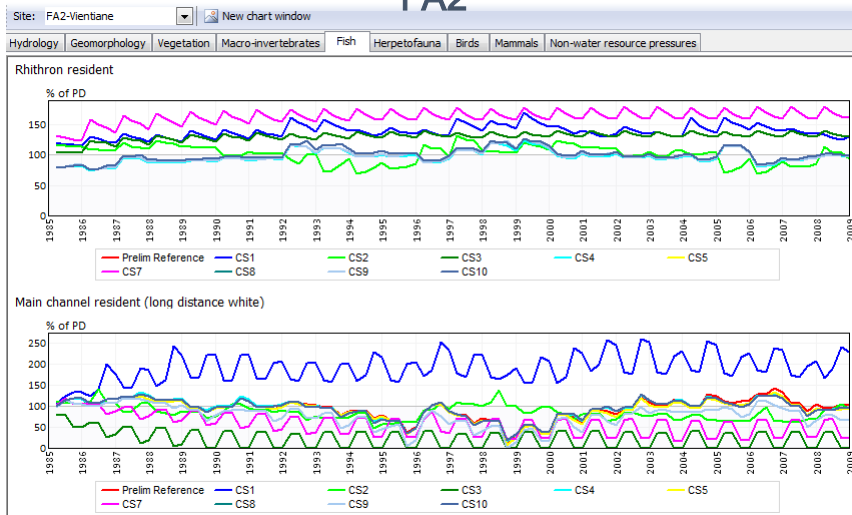
CS 9: Migration blocked between FA1 and 2 AND between FA4 and 5

Barrier deemed to have reduced fish migration as follows:

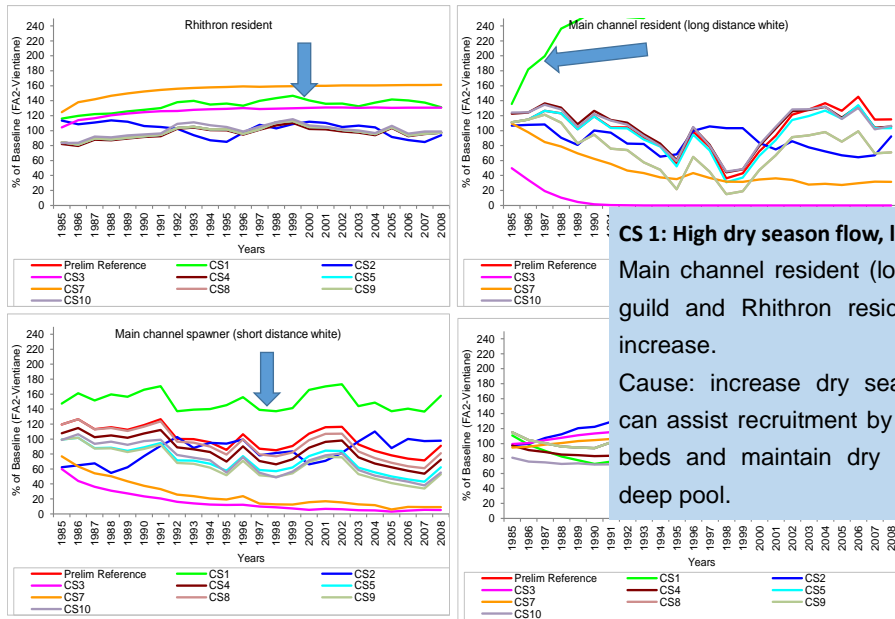
- Upstream migration:
 - G2: Main channel resident – 100% reduction
 - G3: Main channel spawner – 80% reduction
 - G8: Anadromous – 100% reduction
 - G9: Catadromous – 100% reduction
- Downstream migration:
 - Main channel resident – 80% reduction
 - Main channel spawner – 80% reduction
 - Anadromous – 80% reduction
 - Catadromous – 80% reduction.



Individual Fish indicator Response curves to scenarios an FA2

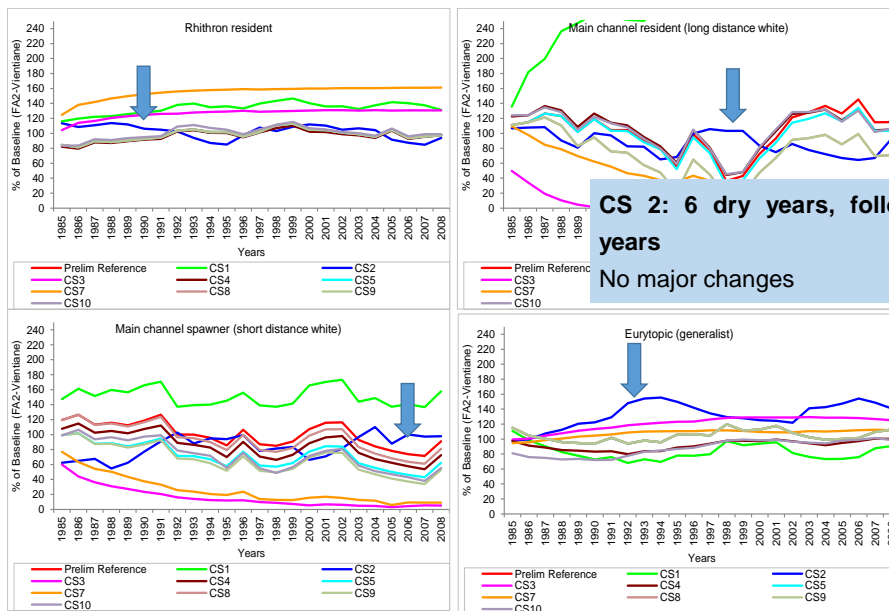


Time-series of predicted changes in fish indicators at FA2 – CS1.



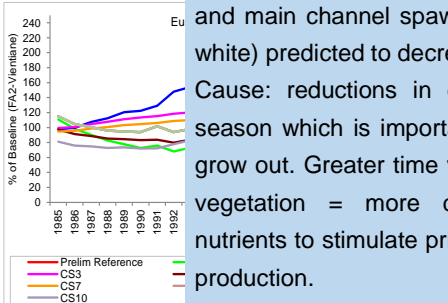
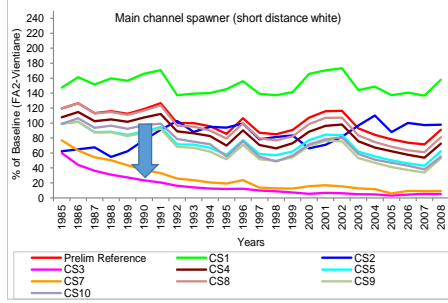
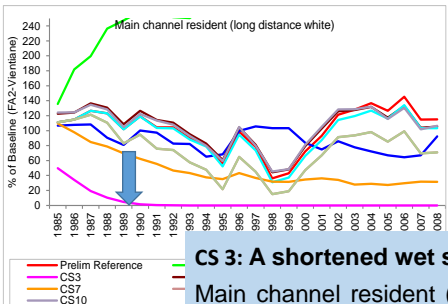
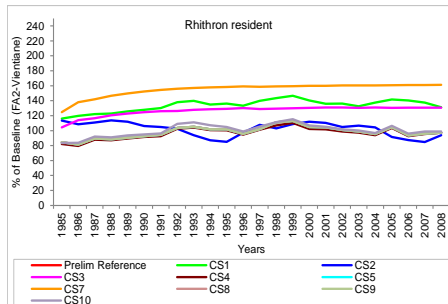
CS 1: High dry season flow, low wet season flow
 Main channel resident (long distance white) guild and Rhithron residents predicted to increase.
 Cause: increase dry season flows, which can assist recruitment by flushing spawning beds and maintain dry season refugia in deep pool.

Time-series of predicted changes in fish indicators at FA2 – CS2.



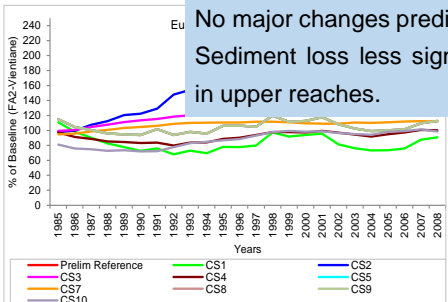
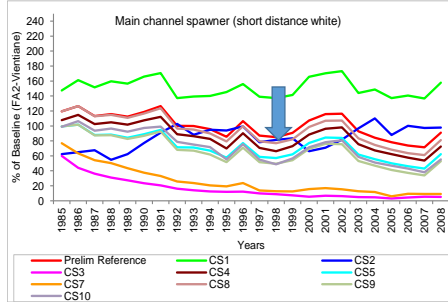
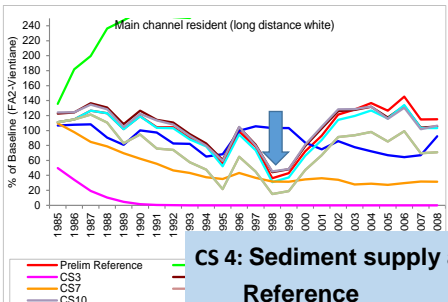
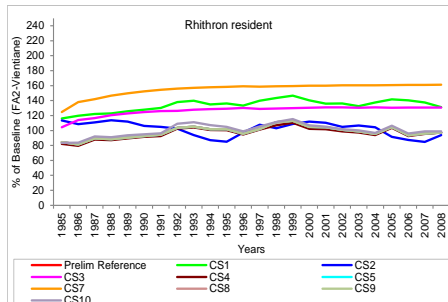
CS 2: 6 dry years, followed by 6 wet years
 No major changes

Time-series of predicted changes in fish indicators at FA2 – CS3.



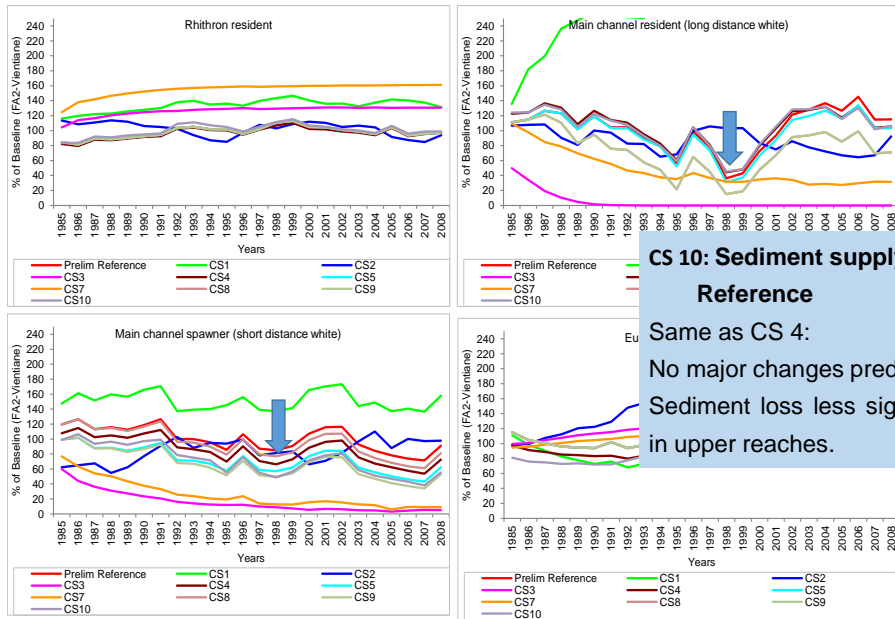
CS 3: A shortened wet season
 Main channel resident (long distance white) and main channel spawners (short-distance white) predicted to decrease.
 Cause: reductions in duration of the wet season which is important for breeding and grow out. Greater time vegetation inundated = more decay and release nutrients to stimulate primary and secondary production.

Time-series of predicted changes in fish indicators at FA2 – CS4.



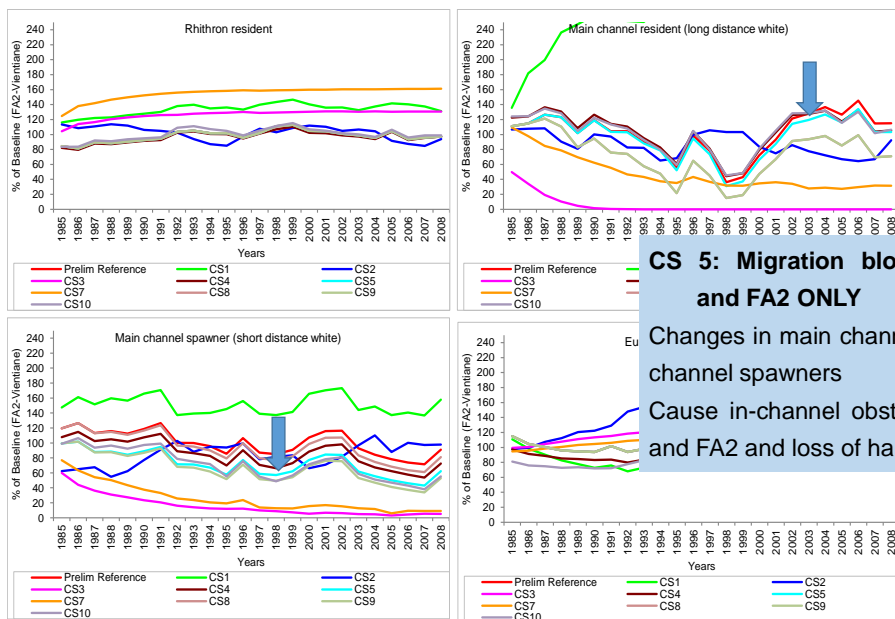
CS 4: Sediment supply at 75% of Reference
 No major changes predicted
 Sediment loss less significant to production in upper reaches.

Time-series of predicted changes in fish indicators at FA2 – CS10.



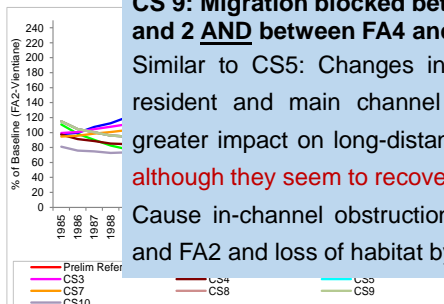
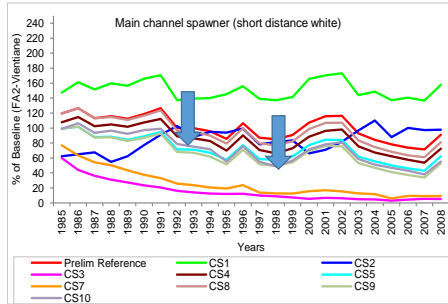
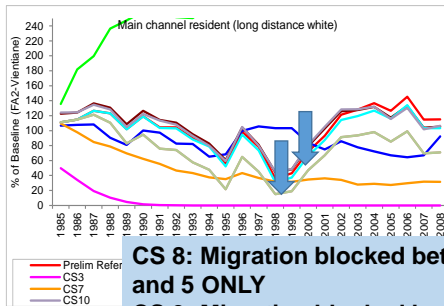
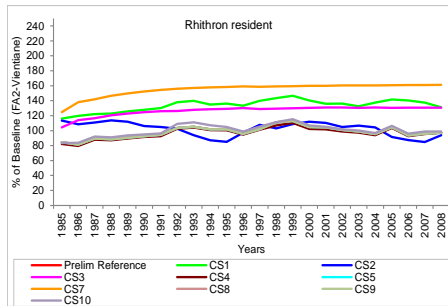
CS 10: Sediment supply at 25% of Reference
Reference
 Same as CS 4:
 No major changes predicted
 Sediment loss less significant to production in upper reaches.

Time-series of predicted changes in fish indicators at FA2 – CS5.



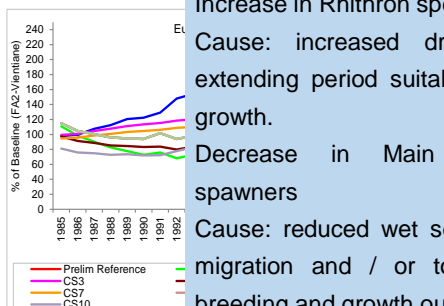
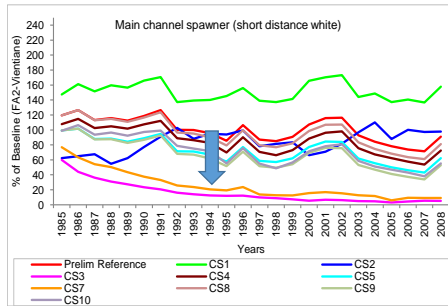
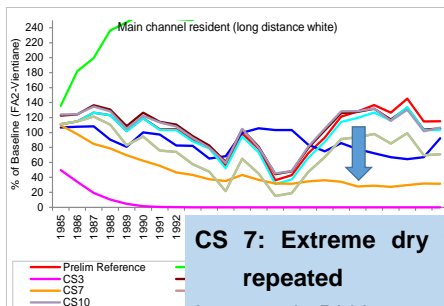
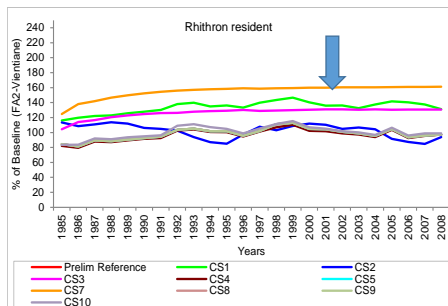
CS 5: Migration blocked between FA1 and FA2 ONLY
 Changes in main channel resident and main channel spawners
 Cause in-channel obstruction between FA1 and FA2 and loss of habitat by flooding.

Time-series of predicted changes in fish indicators at FA2 – CS8 & 9



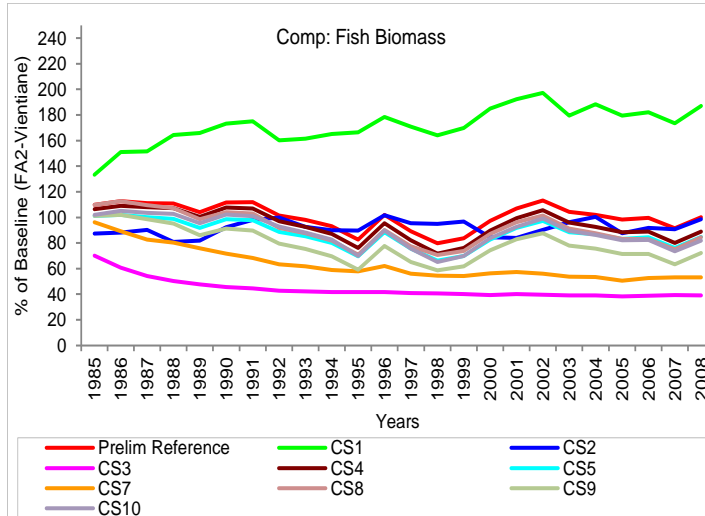
CS 8: Migration blocked between FA4 and 5 ONLY
CS 9: Migration blocked between FA1 and 2 AND between FA4 and 5
 Similar to CS5: Changes in main channel resident and main channel spawners but greater impact on long-distance migrators – although they seem to recover!
 Cause in-channel obstruction between FA1 and FA2 and loss of habitat by flooding.

Time-series of predicted changes in fish indicators at FA2 – CS7.



CS 7: Extreme dry year (1992 – 10%) repeated
 Increase in Rhithron species
 Cause: increased dry season duration extending period suitable for breeding and growth.
 Decrease in Main channel resident spawners
 Cause: reduced wet seasons for upstream migration and / or to the floodplain for breeding and growth out.

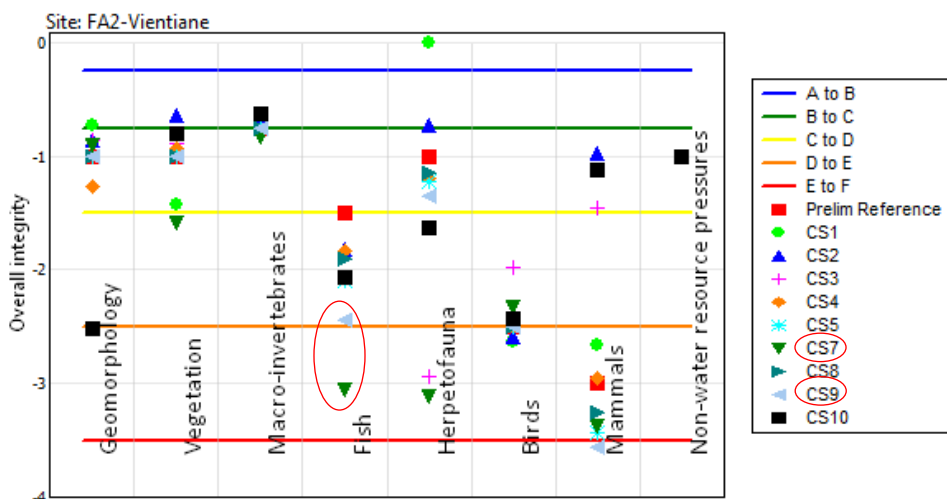
Time-series of predicted changes in fish biomass at FA2.



Biomass at FA2

Biggest impact seems to be impact of reduced seasonal flow conditions CS1, CS3 and CS7
Cause: low flows impede migration of do not provide cues.
Low flows reduce spawning opportunities.

Overall integrity of indicators at FA2.



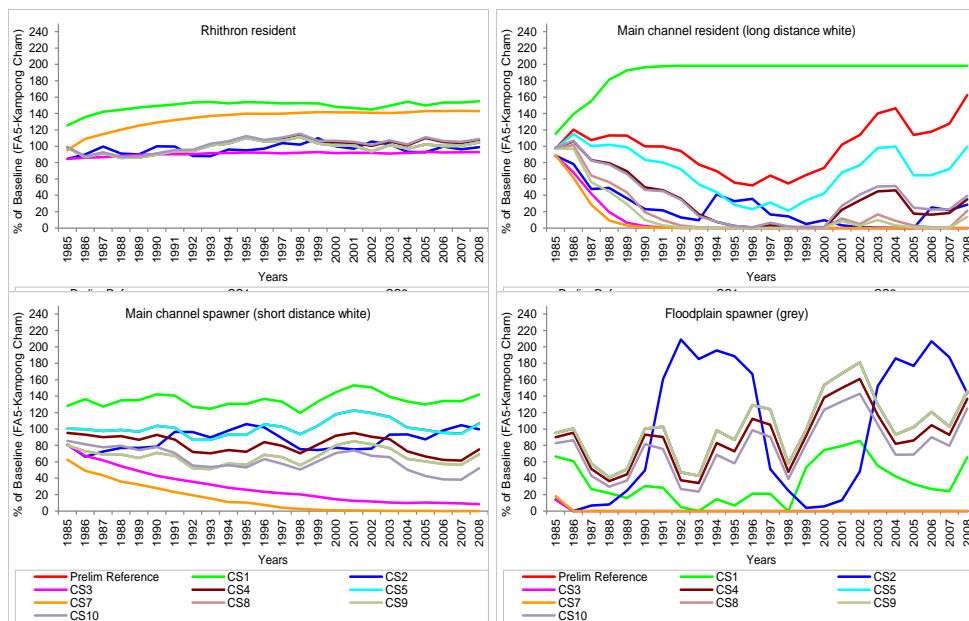
Mean predicted percentage changes in abundance (relative to Reference Scenario) **at FA2** for each scenario.

INCREASES: green = + 40-70%; blue = +>70%.

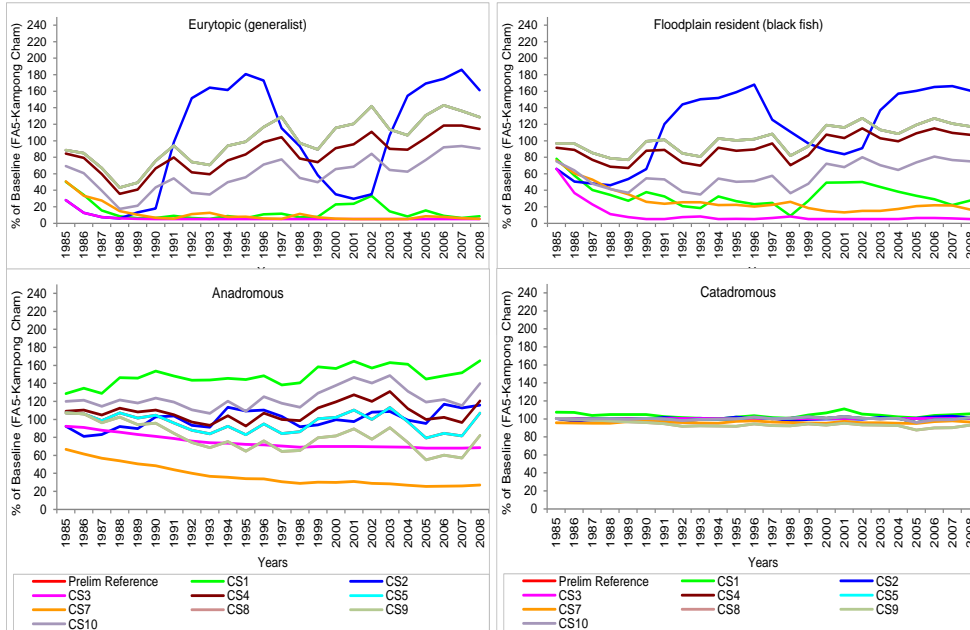
DECREASES: orange = -40-70%; red = ->70%.

Indicators	Calibration scenarios									
	CS1	CS2	CS3	CS4	CS5	CS7	CS8	CS9	CS10	
Discipline : Fish										
Rhithron resident	38.9	1.8	30.8	-2.7	-1.5	62.9	-1.5	-1.5	0.7	
Main channel resident (long distance white)	91.5	-14.6	-76.8	-4.9	-8.2	-42.2	-23.2	-23.2	-5.6	
Main channel spawner (short distance white)	37.5	-12.8	-68.1	-13.2	-22.4	-50.9	-6.9	-26.3	-22.8	
Eurytopic (generalist)	-13.9	21.6	14.0	-6.2	2.4	-10.3	2.4	2.4	-7.1	
Comp: Fish Biomass	45.7	-7.8	-43.9	-7.9	-12.0	-23.6	-9.2	-17.6	-11.7	

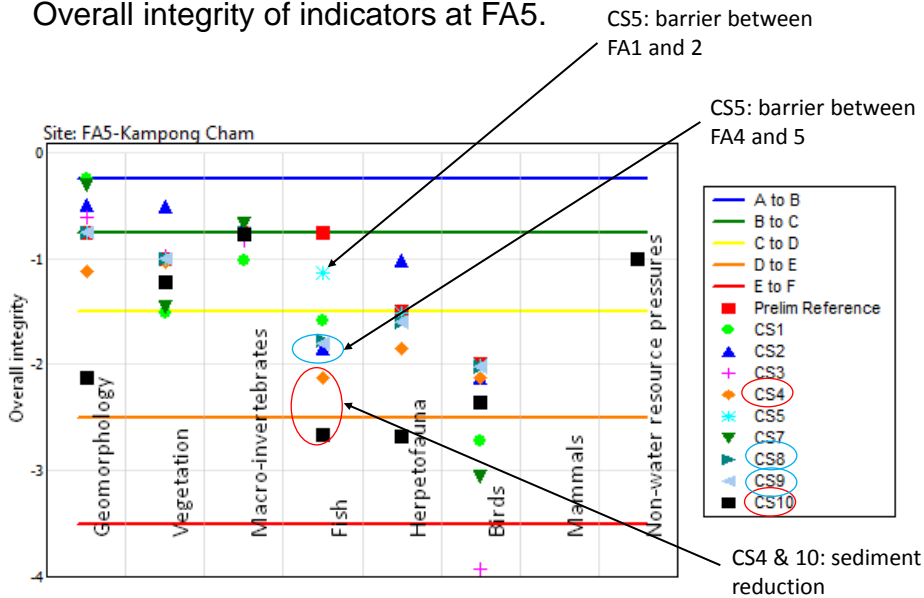
Time-series of predicted changes in fish indicators at FA5.



Time-series of predicted changes in fish indicators at FA5.



Overall integrity of indicators at FA5.



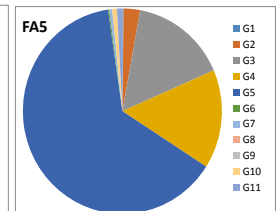
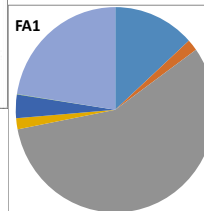
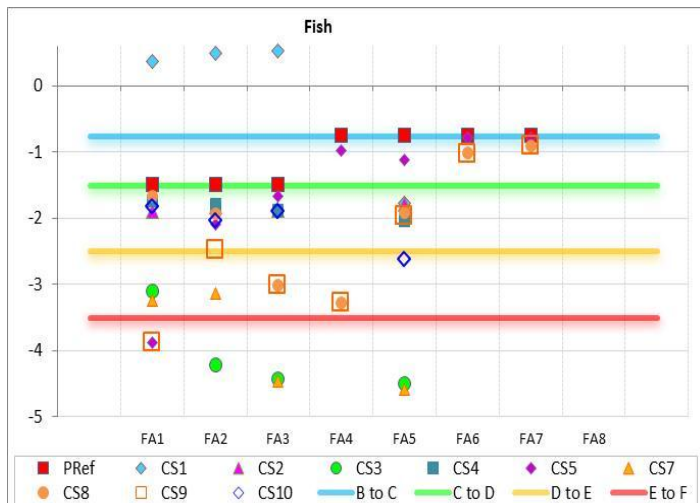
Mean predicted percentage changes in abundance (relative to Reference Scenario) **at FA 5** for each scenario.

INCREASES: green = + 40-70%; blue = +>70%.

DECREASES: orange = -40-70%; red = ->70%.

Indicators	Calibration Scenarios									
	CS1	CS2	CS3	CS4	CS5	CS7	CS8	CS9	CS10	
Rhithron resident	41.8	-3.6	-9.6	-0.2	-2.0	32.8	-2.0	-2.0	0.7	
Main channel resident (long distance white)	44.5	-65.8	-63.4	-64.1	-31.4	-67.7	-59.3	-61.3	-63.4	
Main channel spawner (short distance white)	23.8	-11.1	-49.7	-15.4	-1.8	-60.9	-24.3	-24.3	-27.2	
Floodplain spawner (grey)	-46.6	6.8	-70.8	-8.0	0.1	-73.9	0.1	0.1	-16.3	
Eurytopic (generalist)	-58.1	-4.9	-67.1	-12.5	-2.1	-59.1	-2.1	-2.1	-27.9	
Floodplain resident (black fish)	-51.3	11.6	-70.3	-6.8	1.7	-57.2	1.7	1.7	-32.9	
Anadromous	42.8	3.0	-15.6	6.2	-1.5	-45.7	-12.1	-12.1	16.5	
Catadromous	2.6	0.2	0.1	0.0	0.0	-2.4	-3.9	-3.9	0.0	

Fisheries specific integrity at different focus areas.



CS1 Main channel resident (long distance white) guild and Rithron residents predicted to increase. Cause: increase dry season flows, which can assist recruitment by flushing spawning beds and maintain dry season refugia in deep pool.

Eurytopic fish are expected to do less well, cause competition from the other fish.

CS2: No major changes.

CS3: Main channel resident (long distance white) and main channel spawners (short-distance white) predicted to decrease. Cause: reductions in duration of the wet season which is important for breeding and grow out. Greater time vegetation inundated vegetation = more decay and release nutrients to stimulate primary and secondary production.

Changes in the fish indicators at FA5 under the CSs are similar to those at FA3 but the migration scenarios CS8 and CS9 are predicted to have a great impact on the migratory fish because a barrier between FA4 and FA5 will cut of almost all possibilities for breeding.

CS4: No major changes predicted.

CS5: Major changes in main channel residents and main channel spawners as a result of an in-channel obstruction between FA1 and FA2.

CS7: Increase in Rithron species Cause increased dry season duration extending period suitable for breeding and growth. Decrease in Main channel spawners Cause reduced wet seasons for upstream migration and / or to the floodplain for breeding and growth out.

CS8: CS8 is similar to CS5 in that it is a migratory scenario, but CS8 has a barrier between FA4 and FA5.

CS9: Similar to CS5, but with the addition of the impact at FA4 and FA5.

CS10: Similar pattern of predicted changes as for CS4, but more marked with added reduction in sediment supply.

CS1 increases fish abundance and consequently integrity at FA1, FA2 and FA3, due to increased dry season flows and the associated knock-on effects. However, at FA5, fish integrity decreases under CS1 (the marker is hidden behind that of CS5 in Figure 6.4). This is because the floodplain spawners, floodplain residents and eurytopic fish, which decrease under CS1, make up a bigger proportion of the fish at FA5 than do the other guilds, which increase (Figure 6.5).

CS3 and CS7, which reduce wet season duration and overall flows, have a consistently negative effect on fish integrity across all FAs, as do those that reduce sediment supply (CS4 and CS10).

The predicted effects of the three migration scenarios display a somewhat more subtle pattern. CS5, which has a barrier between FA1 and FA2, has a marked effect on fish integrity at FA1, as it is dependent on the migratory fish making their way up- and downstream of the FA. Downstream of the barrier, the predicted impacts of CS5 are progressively less marked with distance downstream. CS8 (barrier between FA4 and FA5) on the other hand, has the greatest impact at FA3, FA4 and FA5. The combined barriers (CS9) basically reflect the sum of the other two scenarios. Tonle Sap Great Lake (FA7) is not majorly affected by the barriers because the migratory guilds (G2, G8 and G9) make up only a small proportion of the fish community there.