ON DIFFICULTIES IN INTERPRETING PROBABILITY-BASED MEASURES OF RISK IN TRADE-OFF SITUATIONS

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In a number of recent instances, the Pelagic Working Group has been finding itself in difficulty when selections need to be made between management options where the trade-off involves a measure of risk, typically expressed as the probability of abundance dropping below some chosen low level. The essential problem is that even if one makes a management measure considerably more onerous, this achieves only a small change in this probability. Understandable argument from the industry then is why such a heavy penalty if it achieves so little – is this marginal reduction of the risk measure meaningful?

The Table below illustrates such a situation. It relates to a spatial management issue. The precise details do not matter for the key point at issue here. The essence is that if industry distribute their operations spatially as in the past ("Behave"), the probability in question is 12.8%. If they do not ("Misbehave" in various ways), this probability increases to almost 14%. Measurable Penalty and Benefit thresholds have been set (which do admit the possibility of false positives and false negative decisions), such that if the first threshold is exceeded, the TAC that would otherwise apply is decreased by a certain proportion for future years; similarly, if the second threshold is crossed, it is increased by a different proportion. Furthermore, this multiplicative TAC adjustment factor decays towards 1 each year by a further proportion.

The Table shows how various choices for the sizes of these adjustment factors (OMPs Opt1, Opt2, Opt3) result in ameliorating the effects of any "misbehaviour" compared to the original OMP (here denoted CMP3). But the difficulty is that quite large changes are required (such as a TAC reduction ~10%) to achieve a meaningful impact. An annual decay of such a penalty by 20% instead of only 10% (and note that this for only a single indicated "offence", which also has a relatively high probability of being a false positive) increases the "risk" probability by only 0.1%. The greater advantage to the industry of the 20% rather than the 10% decay rate choice is understandable and clear, but how is the associated purported disadvantage of the 0.1% in the "risk" probability most readily interpreted?

Are there potential better ways of measuring this benefit so that it can be better understood? For example, should one rather consider only situations where the simulated population does in "reality" drop below the actual threshold (the computer conducting the simulations "knowing" the real value of abundance), and then gauge the differential success rates of different options for seeing the population recover above that threshold (and quickly so)?

Table: The probability of dropping below a chosen low level of abundance is indicated by *p*, and the expected annual catch by *C*.

Industry Behaviour	OMP	Annual readjustment towards 1	Penalty if red flag	Benefit if green flag	$p(B_w^S < 150)$	C_{tot}^S
Behaves	CMP3	N/A	N/A	N/A	0.128	104
	Opt1	10%	-0.10	+0.03	0.126	101
	Opt2	20%	-0.10	+0.01	0.125	101
	Opt3	20%	-0.075	+0.01	0.126	102
Misbehaves A	CMP3	N/A	N/A	N/A	0.138	104
	Opt1	10%	-0.10	+0.03	0.131	98
	Opt2	20%	-0.10	+0.01	0.132	99
	Opt3	20%	-0.075	+0.01	0.133	100
Misbehaves B	CMP3	N/A	N/A	N/A	0.139	104
	Opt1	10%	-0.10	+0.03	0.132	95
	Opt2	20%	-0.10	+0.01	0.133	97
	Opt3	20%	-0.075	+0.01	0.134	99