Summary of suggested baseline options for rock lobster TAC recommendations for the Tristan da Cunha group of islands (i.e. had no oil spill event occurred in 2011)

S.J. Johnston and D.S. Butterworth

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This document presents four options for what would have been the basis for recommending TACs for the rock lobster resources at the four Tristan islands had the oil (and soya) spill event not occurred. Though pertinent to the coming season, the rationale for a number of these options is also linked to longer-term optimal sustainability considerations. The longer-term implications of the differences between these options are illustrated by providing resource projections based on the most recent age-structured model assessment of these resources.

Option 1: *Maintain current TACs unchanged*

This option is presented more by way of providing a basis for comparison of consequences against the alternatives below, rather than as a serious "contender". There are a number of reasons why this option should be refined/replaced:

- The current TACs were based in large part on replacement yield (RY) calculations using simple age-aggregated population models, which have since been replaced by more realistic age-structured models which also take account of catch-at-length information and data on discards. Those earlier RY estimates should be updated using these newer models.
- These refined models are able to provide some indication of the status of these lobster resources relative to typical international benchmarks to achieve optimal productivity from marine resources, which should be taken into account in finalising a harvesting strategy.
- Since those previous RY computations, there has been a marked decline in CPUE at Inaccessible, and to a lesser extent at Tristan and at Nightingale.

Option 2: *RYs based on maintain current (2011) exploitable biomass levels*

Calculation of RY's is more complex for age-structured population models because of "transient" effects – the effects of changing catch levels takes time to filter throughout the population because lobsters are relatively long-lived, and can result in population fluctuations in the short to medium term. Long-term replacement yields (RYs) assume a constant catch into the future, and find the value of this catch which results in the long term exploitable biomass of the population (taken to be in 2066 to ensure that transient effects have dropped to zero) is at the same level as that in 2011, i.e.

$B_{exp}(2066)/B_{exp}(2011)=1.0$. The underlying assessment models estimate recruitment residuals for the 1992-2005 period. Here, RYs are calculated assuming future (2006+) recruitment is at the 1998-2005 average level (i.e. excludes the large peak of past estimated recruitment in the average). The underlying models used for these RY calculations are the recently updated 2011 age structured population models which take into account time varying selectivity. Results of such calculations are shown in Table 1, and compared there to current TACs and previous RY estimates based on a simpler age-aggregated model.

Table 1: RYs for each island assuming future recruitment is at the 1998-2005 estimated level and for models for which F_{2009}=0.3 and discard CV=0.8. The TAC and actual catch levels for 2010/1011 season are reported, as well as the RYs estimated by MARAM in 2010 using simple replacement yield models. All quantities are in MT.

Model	RY	Bsp(2011)/Ksp	Bexp(2011)/Kexp	TAC(2010/11)	Catch(2010/11)	RY estimated in 2010*
Inaccessible	88	0.89	0.58	105	53	106
Nightingale	76	0.74	0.41	72	63	75
Gough	75	0.87	0.42	88	87	88
Tristan	174	0.86	0.41	185	181	172
Total	413			450	385	441

*These RYs correspond to RYs calculated by MARAM using a simple replacement yield model, where the conservative assumption that F_{1997}=0.7 was assumed.

This approach has the difficulty that in a number of cases the assessments estimate the population spawning biomasses to be near pristine (pre-exploitation) levels. As such levels are approached, RY drops to zero because resource productivity is increasingly curtailed by density-dependent effects (reduced somatic growth rate and increased mortality as a result of food limitations coming into play). Higher yields are possible at lower abundances, and would be fully sustainable. Thus, for example, this option would see the Gough TAC reduced because this resource is now estimated to be close to its pristine abundance, in circumstances where there appears to be no biological need for such a reduction.

Option 3: *Targeting the same spawning biomass level for all four populations (85% of pristine*)

This option attempts to adjust for the problem raised immediately above for Option 2. The new assessments estimate the current spawning biomass as a proportion of pristine to range from 78% to 91% across the four populations. For a consistent common standard, the same target of 85% of pristine is set for each.

The rationale for the 85% choice is pragmatic – it is about the average of the current values for the four populations. This is considerably higher than is the conventional norm in fisheries, which is typically in the 30-40% range.

However, despite the extremely conservative nature of the approach which the previous paragraphs suggest, there are reasons for caution at this stage, and further reasons that suggest Option 3 might yield TACs that are too high (at least at this stage of the fishery's history):

- The relatively high levels of spawning biomass estimated in the recent age-structured assessments have a large "cryptic biomass" component made up of large lobsters apparently not available to the fishery for whatever reason (in deeper waters perhaps). Further independent verification of the existence of this cryptic component would be desirable before decisions accord it perhaps undue weight.
- The age-structured models are very recently developed, and might benefit from further refinement.
- In some cases the resultant TACs would result in decreases in current levels of exploitable biomass; the catch rate in the fishery is proportional to this component of the biomass, and so would also drop below current levels, with resultant increases in harvesting costs which might be undesirable for the industry.

Option 4: *Compromise (between Options 2 and 3)*

This option attempts a balance between the previous two options which maintains some of their strengths while reducing some of their disadvantages. The specific suggestions under each option are set out in Table 2 below.

[N.B.: Values in Table 2 are subject to recalculation given clarification and decision on the most appropriate somatic growth rate functions to use for each population.]

Table 2: Four options for TACs (MT) for 2011/12 season

TAC 2011/12	**Inaccessible**	**Nightingale**	**Tristan**	**Gough**	**Total**
1) Unchanged	105	72	185	88	450
2) RY based on B_{exp}	88	76	174	75	413
3) All Bsp(61)/K=0.85	110	55	220	90	475
4) Compromise	95	72	190	88	445

The Figures that follow hopefully assist in comparing the consequences of adopting any of these four options. All show assessment results for each population from 1990 to 2011, followed by projections for the next 50 years (though transient effects have effectively disappeared with stability reached after about 30 years). The projections are shown for both the exploitable and spawning biomass components of each population.

Fig. 1 shows trajectories separately by island for each of the TACs suggested for that island under the options in Table 2, with results presented as proportions of pristine levels. Fig. 2 repeats this, but groups results by option, with each plot showing the consequences under that option for each island. Finally Fig. 3 repeats Fig. 2, but shows results relative to 2011 abundances instead of relative to pristine abundances.

Thus for example Fig. 3 shows that under Option 3 with a target of 85% of pristine spawning biomass for Tristan, the exploitable component of the biomass, and hence the CPUE, would drop well below recent levels, suggesting a TAC set undesirably high. At the other end of this spectrum, for Nightingale the reduction in TAC that occurs through aiming at this 85% target leads to greater eventual CPUEs and spawning biomasses than seem necessary for optimal utilization. Both Figs 2 and 3 show that compared to Option 3, the compromise of Option 4 sees much less spread in future CPUE levels compared to current, at the expense of relatively little broadening of the spawning biomass target amongst the four populations.

Figure 1: Trajectories of B_{exp}/K_{exp} (left hand side plots) and B_{sp}/K_{sp} (right hand side plots) for each TAC options for each of the four islands.

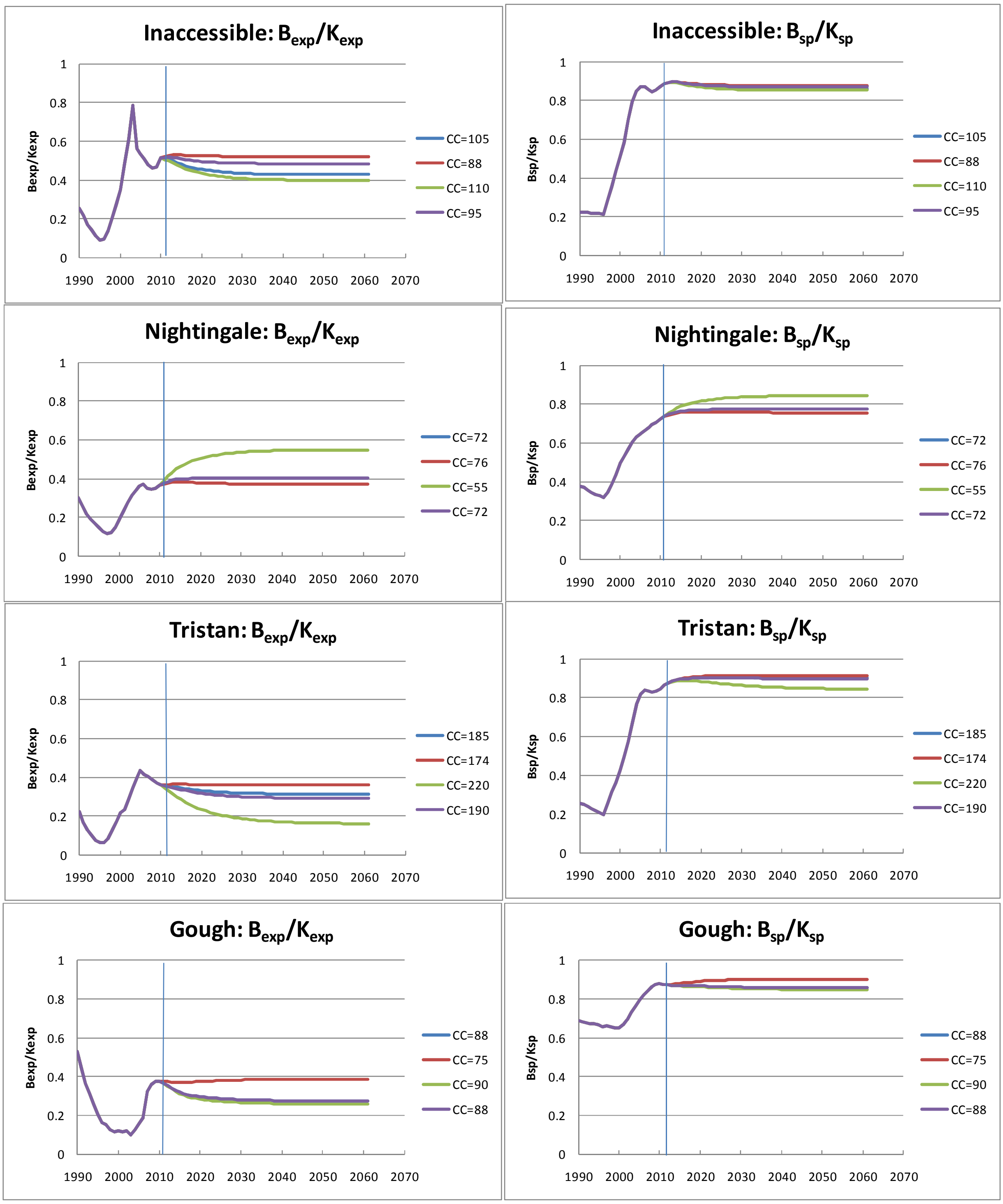

Figure 2: Trajectories of B_{exp}/K_{exp} (left hand side plots) and B_{sp}/K_{sp} (right hand side plots) for each of the TAC options comparing the four islands.

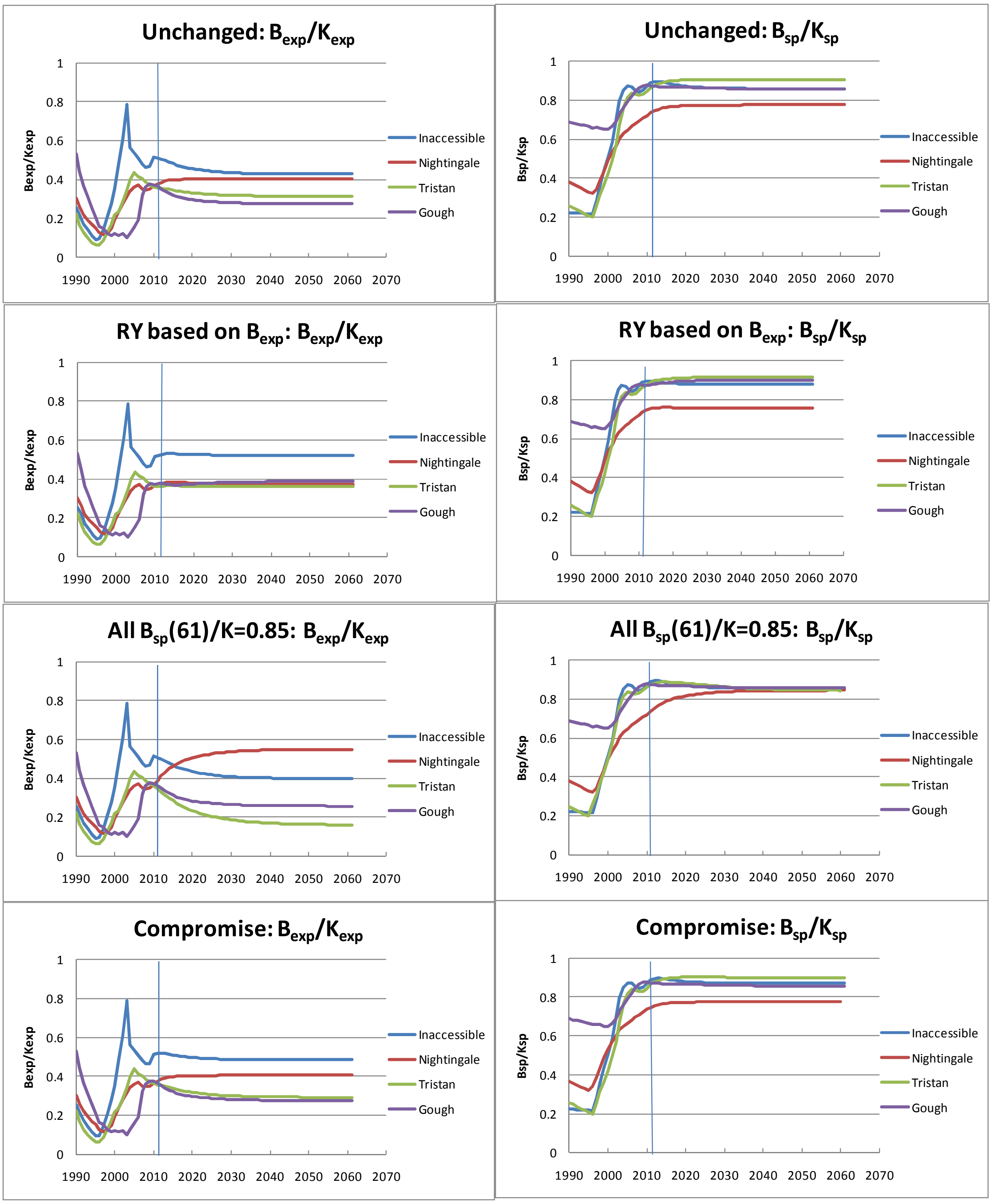

Figure 3: Trajectories of $B_{exp}/B_{exp}(2011)$ (left hand side plots) and $B_{sp}/B_{sp}(2011)$ (right hand side plots) for each of the TAC options comparing the four islands.