A REBUTTAL OF SOME ELEMENTS OF THE ATTWOOD-NEL COMMENTARY ON A PREVIOUS ANALYSIS BY THE AUTHORS OF SOME IMPLICATIONS OF A PROPOSED MPA IN THE PRINCE EDWARD ISLANDS VICINITY, WITH SOME CONSEQUENT SUGGESTIONS

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For readers' ease in cross reference, the rebuttal comments of this paper have been inserted in the text of the Attwood and Nel commentary which is duplicated below. For ease of identification and distinction, rebuttal comments have been numbered and set down in ***italics***, with the original commentary to which they refer shaded.

At the end of these comments, some suggestions are made regarding issues meriting further consideration in this matter.

Reply to Butterworth and Brandão (2007): Some implications of proposed Marine Protected Areas (MPAs) in the Prince Edward Islands vicinity for the toothfish (*Dissostichus eleginoides*) fishery

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Butterworth and Brandão (2007) have presented a critique of a proposal for a marine protected area around the Prince Edward Islands, and have questioned whether the proposal will attain two of the four stated objectives, namely to

2) to serve as a scientific reference point that can inform the future management of the area; and

3) to contribute to the recovery of the Patagonian toothfish *Dissostichus eleginoides* which has been so over-exploited that its spawning biomass may be only a few percent of pre-exploitation levels just ten years ago (Brandão *et al*. 2002).

In this paper we respond to these questions and clarify some of the details behind the original proposal, which was concluded following a detailed planning process involving all stakeholders, from 15 June 2005 to 26 May 2006. Three stakeholder workshops as well as several 'one-on-one' consultations with industry were conducted during this period (Nel *et al.* 2006).

A final workshop including government, fishing industry and conservation NGO representatives was held on 16 May 2006 to discuss and refine a proposal for a comprehensive, zoned marine protected area around the PE Islands to achieve four objectives (Nel 2006). We begin with a short, selective review of workshop outcomes, which should illustrate that most of the concerns raised by Butterworth and Brandão (2007) were discussed at the workshop.

Background: 2006 workshop

To assist in the recovery of the toothfish fishery, was seen as one of four objectives of the proposed marine protected area. The workshop was clear the final delineation of the MPA should one which seeks to address aspects of all four objectives, but that the MPA alone could only contribute towards the achievement of these objectives and not achieve it on its own. In respect to how the MPA contributes to the rebuilding of the stock of toothfish,

*1) As elaborated further below, the key issue here is not **how** the MPA contributes to rebuilding, but **whether** as currently conceived there is any basis to expect it to make **any** such contribution.*

the workshop agreed that this should be done ***without*** compromising the economic viability of the fishery. There was general acceptance of this point amongst all stakeholders. The fishing interests were concerned that an already marginal economic operation could be jeopardised by unduly harsh area restrictions and that the removal of a presence of South African vessels would open the doors further to IUU fishing. This danger was understood by all.

Fishing industry representative were eager to point out that delays and mis-management of the toothfish resource in the PE Islands resulted in massive IUU fishing, which cost South African fishing interests dearly in terms of lost catches and now a depleted resource. Certainly there was a general understanding that the toothfish population at the PE Islands was heavily impacted and that, being a long-lived species, recovery would be slow. This was backed-up by the earlier assessment by Brandão *et al*. (2002) and an examination of raw catch data and fishing effort distribution.

Against this understanding, it was proposed that a restriction of fishing effort in some grounds known to hold toothfish would greatly assist in the recovery, while still allowing a reduced harvest in remaining areas.

2) See comment 8) below.

Specifically it was agreed that leaving the area around the islands would be beneficial by protecting juvenile toothfish.

3) Is their evidence that such action achieves such protection or that this is more beneficial than the same catch made elsewhere? Fig. 1 shows the time trend of the proportion of longlined toothfish less than 60 cm in length caught over the history of the fishery. Though there was some initial decline as the fishery expanded from its original area of concentration close to the islands, in the longer term there is no real trend. The estimated selectivity curve for longlines rises steeply from zero at a toothfish age of 6.5 years, whether one considers the earlier or later years in the fishery (see Brandão and Butterworth, 2007, Fig. 4 and Table 4). Thus few fish of an age younger than this are caught. Fig. 2 shows cohort biomass for toothfish as a function of age in an unexploited situation. Given that the bulk of the longline catch is *between 60 and 90 cm, and that the declining selectivity indicated at larger ages for this fishery may in part be an artefact of the standard value assumed in CCAMLR for M for toothfish perhaps being somewhat too low, there is no indication that there is any appreciable loss in yield-per-recruit terms to the fishery through use of longlines under past spatial distributions of fishing. The comparative MSY estimates for pot compared to longline selectivity (Brandão and Butterworth 2007, Table 4), where the curve for pots is shifted somewhat towards older ages, suggests an effect of only some 10%. The particular pertinence of these considerations will become evident from suggestion F) at the end of the document.*

An analysis was made of fishing effort (hooks set) patterns (Lombard *et al.* 2006), suggested that the proposed restricted zones would affect on average 43% of the legal fishing effort, based on hook data post-2000 (range 36% -48%). Absolute effort trends show a sharp reduction in hooks set since 2000, and an even greater reduction in total catch over this period, which was seen as a general reflection of the state of the resource.

4) This differential effect is likely primarily the result of cetacean predation which commenced in about 2000 (see Brandão and Butterworth, 2007, Fig. 2 and Table 2).

For the pot fishery with only a three-year time-series, there could be no trend, but in the 2005 year over 50% of the effort was in areas not proposed for fishery closure.

It was evident that the distribution of catches had shifted away from the islands since 1996. This shift was interpreted as a move towards deeper water as the shallow water areas became progressively depleted.

5) Indeed, but it is hardly likely that this reflects the depletion of a separate shallow water stock in the neighbourhood of the islands. What merits more attention is whether this indicates instead the reduction of density in hot-spot areas in the initial stages of the fishery (where these areas did not account for that large a proportion of the total abundance of the stock) to average density levels elsewhere. This scenario seems increasingly plausible as further catch-at-size information has become available from the fishery, and has important implications – see comment 14) and suggestion F) below.

The need to monitor the restricted areas was discussed at length, and it was agreed that some exploitation of restricted areas was necessary if these areas were to serve as a fishery benchmark. Further, it was noted that it was best to use industry vessels, for the sake of comparability and economy, for such monitoring, such that the zoned MPA would not exclude fishing from any area, (except the 12 nautical mile areas around islands that they are currently excluded from), but merely redistribute effort in such a manner that the restricted areas be harvested with a capped effort.

6) See comment 8) below.

The need to scale the redistribution in such a manner that statistically useful data would emerge from both areas was raised at the meeting, but there was no attempt to quantify the minimum effort required for monitoring in ‘restricted areas’.

7) Without such quantification, the proposal cannot with scientific defensibility claim “to serve as a scientific reference point that can inform the future management of the area” in respect of toothfish. See also comment 30) below.

In an effort to not compromise the viability of the existing fishery and to allow for comparable monitoring, the workshop decided that effort should be capped at the average number of hooks set in these restricted zones during the period 2001 to 2005.

The current recommendation is therefore extremely unlikely to affect the economic viability of the fishery.

8) See also commentary highlighted in relation to comments 2) and 6) above and 12) and 16) below. If the intention of the proposal is merely to cap effort in certain areas at its average 2001-2005 level (note Nel 2006 states 2002-2005) (and without changing the nature of that effort), how will that "greatly assist in the recovery" of the resource, since (Attwood and Nel seemingly imply) there hasn't been (adequate) recovery over that period under the same circumstances? Note that this question follows even if one makes the seemingly low plausibility assumption that the proposed protected areas contain separate stocks reproductively isolated from other areas on time scales comparable or longer than those associated with recovery. In other words, given that this is a TAC-controlled fishery anyway, what difference will this imposition make to the recovery of the resource?

However, the proposal as drafted in Nel (2006) goes much further than Attwood and Nel seemingly imply here (and correctly so, if these areas are to be genuinely promoted externally as MPAs in a toothfish context, rather than "business as usual" for the fishery). Specifically it states (paragraph 3.2.3): "Toothfish populations in these areas will be monitored using standardized commercial fishing techniques. The DEAT may enter into an agreement with permitted commercial rights holders to perform these monitoring activities as part of their permit conditions. The extent of the monitoring effort will be determined by DEAT scientists in consultation with commercial rights holders. The monitoring effort should not exceed the average number of hooks set in each of these zones over the period 2002 to 2005 and the total effort in the restricted zones should never exceed 40% of the total effort in the EEZ". This is certainly not necessarily "business as usual "extremely unlikely to affect the economic viability of the fishery":

a) The catch to be taken in these monitoring exercises (reserved for the MPAs) will (presumably) be a component of the TAC, but is not guaranteed to be allocated to existing rights holders.
b) If catch rates outside the MPAs in a particular year are poor, the industry is obliged to fish there to the level of at least 150% of the effort it expended in the MPAs even if that is proving uneconomic.
c) "Monitoring" is a scientific exercise. The external scientific community (at least) would expect a detailed survey sampling plan, likely involving spatially fixed stations and time windows for their sampling. But typically such operations are less economically efficient for the vessels concerned than their normal fishing operations. This could substantially impair the viability of what is currently advised to be an economically marginal operation.

It was agreed that the need for effective policing and deterrents to IUU fishing was paramount to the success of the MPA. The fishing industry pointed out the positive role played by their vessel(s) as a means to detect, report and deter foreign and illegal fishing. Whereas this was accepted, the workshop agreed that quite obviously, this alone would not suffice and that a bold commitment from government was required to police its EEZ, for the protection of SA's economic interests and for the sake of conservation. This commitment would not need to be any more than that would be reasonably expected for normal surveillance required for this area. In fact the delineation of an MPA should lead to a more informed compliance strategy that focuses effort on the most important biodiversity and marine resource assets of the EEZ, and thereby a streamlining of resources.

Issues raised by Butterworth and Brandão (2007)

1. The MPA may affect the viability of a fishery that is purported to be economically marginal, leading to a withdrawal of SA vessels which in turn could increase IUU fishing, and have an effect opposite to what was intended.
2. Without reducing TAC, how will the MPA lead to a recovery? The authors were uncertain over the intention with respect to TAC – this issue was not addressed in the Nel (2006) proposal. Furthermore the authors point to their new assessment of the toothfish resource, which pegs the abundance at close to 40% of pre-exploitation biomass, although the assessment is still subject to considerable uncertainty. Their point is that a fish resource near 40% of pre-exploitation biomass, while over-exploited, is not in a desperate state, and certainly does not require a radical, effort-displacing rebuilding strategy.

*9) Our earlier contribution (Butterworth and Brandão 2007) on this topic did not in any way state or imply that a fish stock near 40% of its pre-exploitation biomass was "over-exploited". This level is almost twice the estimated MSY level for this fishery (Brandão and Butterworth 2007, Table 4), and does certainly **not** reflect a state of biological over-exploitation. This is not to argue that the 40% estimate does not have important associated uncertainties (which is a core reason for the OMP evaluation work currently being conducted), that MSY level should necessarily be the management target for this or other SA fisheries, or that there may not be a case for economic reasons for seeking an increase in present abundance of this resource to enhance catch rates. However, unless it reflects a misunderstanding, this qualification by Attwood and Nel raises wider concerns about what the overall WWF MPA initiative for SA fisheries sees as appropriate target abundances for SA fish resources compared to conventional fisheries targets for optimal utilisation.*

3. The re-zoning of the grounds may lead to a change in fisherman behaviour, size-selectivity and catchability. The OMP under development uses mean size as an indicator, and any substantial change in the above-mentioned variables may render this index unreliable for assessment.
4. Power analysis indicates that the likelihood of detecting trends in CPUE in closed areas is very small, and that the objective of using closed areas as a reference will probably not be achieved.

Response to issues raised by Butterworth and Brandão (2007)

1. Displacement from fishing grounds

Butterworth and Brandão (2007) allege that the MPA will affect more than 50% of the fishing effort

10) Our original words were "typically 50%", intending to give a coarse impression of the magnitude of the proportion in question.

whereas Lombard (2006) showed figures suggesting that on average only 43% of effort will be affected. The difference is attributed to the use of the different data formats. Lombard (2006) used *hooks* whereas Butterworth and Brandão (2007) used *sets*. Given that the number of hooks vary between sets, we suggest that the former provides a more accurate measure of effort. The workshop outcomes were based on an understanding of displacement using hook data.

11) Fig. 3 compares the effort proportion in the proposed MPAs by year as measured by sets and by hooks. There is generally little difference, though the proportion by sets is notably higher in 2001, 2004 and 2005. Qualitative conclusions are independent of the approach used. It should be noted that all CPUE analyses quoted in Butterworth and Brandão papers use hooks as the unit of longline effort.

Even so, the proportion of effort that will be affected will be far less than 40%, due to the need to maintain some fishing (by the rights holders) in the restricted areas. Under the workshop recommendation (Nel *et al.* 2006) of capping the effort in these restricted zones at the average levels between 2001 and 2005, the impact of fishing effort will be minimal, if anything. The scenario sketched by Butterworth and Brandão (2007) is biased and displays a complete misunderstanding of the process and the spirit in which these recommendations were negotiated.

12) Comment 8) above addresses these points.

Are the restricted areas the most productive grounds? The data prior to 2005 show that this was the case, though not by a huge margin. The more recent data suggest a substantial reverse in the trend, although the data became considerably more variable in the last two years.

13) We caution that the words "productive grounds" not be misinterpreted to necessarily imply separate stocks with differential surplus production. The issue here is local toothfish density which relates to catch rates.

The question whether or not there were significant differences in CPUE between protected and unprotected areas was overshadowed by the understanding that the CPUE everywhere had declined by an order of magnitude everywhere,

14) Fig. 4 plots GLM-standardised CPUE by area (areas A, B, C and D as indicated in Fig. 1 of Butterworth and Brandão, 2007). There certainly was a major drop in CPUE from 1997 to 1998 in areas A, C and D. The trend after 1998 is however not so clear, as if the estimated cetacean predation from 2000 is factored in, there is little indication of much further decline – see comment 4) above. With the passage of time, assessment models have increasingly struggled to reflect this highish 1997 CPUE value (e.g. see Figs 5 and 6 of Brandão and Butterworth, 2007), which was originally interpreted as evidence of very heavy depletion of the resource in the mid-1990s by IUU fishing. The primary reason has been the further incorporation of catch-at-length information in the assessment, and particularly that from the pot fishery which operated over 2004 and 2005. Simply put, although clearly there was some decline in the 1997-1998 period, if it was as large as the 1997 CPUE data suggest, the particularly large-sized toothfish caught by the pot fishery couldn't have been as they'd already have been fished out earlier. Thus the plausibility of the hypothesis that the 1997-1998 CPUE decline represents to some extent a fishing down of local high density hotspots, rather than a near comparable overall drop in abundance, is growing.

and that the values measured now might recover everywhere if spawner-biomass (and recruitment) is allowed to recover.

15) See comment 21) below.

The question is further made irrelevant by the fact that the workshop recommended that effort in the restricted areas be capped at the average levels between 2001 and 2005. The rights holders' ability to fish in these areas would therefore be impacted minimally, if any.

16) See comment 8) above.

2. How will closure help and how will TAC be affected?

The advantage of fishery closures apply in situations where recruitment has failed due to excessive exploitation and where effort is poorly controlled. In the toothfish fishery uncontrolled effort remains a problem

17) Yes, but the MPA declaration per se does not assist as IUU fishers are hardly likely to adhere to it.

– it appears to be of the same order as the legal catch. Additional losses to killer whales inflate the fishing mortality further. Whereas the assessment procedure adopted by Brandão and Butterworth (2006) attempts to estimate these additional losses, the fact remains that SA has very poor control over toothfish mortality at the PE Islands. What was understood at the workshop was that it was in SA's long-term interest to secure protection for a substantial portion of toothfish habitat, to hasten its recovery

18) The MPA-related mechanism by which enhanced recovery is supposed to occur is not explained – if the TAC is maintained, how will restricting fishing effort in some part of the habitat lead to faster recovery than if fishing occurred ("evenly") throughout the range? Not at all if this is a single well-mixed stock. Toothfish are not sedentary – Marlow et al. (2003) report typical movements of some 15 nm annually in the South Georgia vicinity. Though calculations would need to be carried out to check the implications for the PEI region more closely, this would seem to suggest diffusion in and out of the proposed MPAs on a time scale at least as rapid as the resource dynamics, even if the areas of the proposed MPAs are taken to reflect different stocks with their own dynamics. "Hastening recovery" without compromising TACs seems possible only if different areas contain effectively reproductively isolated stocks.

and to serve as a refuge for older, mature fish, which is regarded as a necessary step to restore recruitment.

19) See comment 25) below.

The recent (2006) assessment provided a pleasant surprise to most of us. If the toothfish stock at the PE Islands is indeed at 39% pre-exploitation biomass, then it would appear that the stock is in better shape than many other commercial stocks in South Africa. Certainly, we were under the impression that the stock was at a far lower level, judging from the trend in CPUE and the changes in effort distribution.

20) See comment 14) above.

Even accepting this estimate, the model suggests that recruitment is still substantially below its pre-exploitation strength and that a stock-rebuilding strategy is required.

21) We apologise if some misunderstanding may have arisen here as a result of an error in the plots of estimated recruitment time series in Brandão and Butterworth

(2006); these are correctly shown in Brandão and Butterworth (2007, Fig. 1). It is important also to realise that the assessment allows for random fluctuations about the input stock-recruitment curve, and this leads to some past years in which recruitment is estimated to have fluctuated well above its median unexploited level. Thus original and current median recruitment levels do not differ as much as the plots in Brandão and Butterworth (2006) considered by Attwood and Nel indicated. Nevertheless, if the resource is indeed at some 40% of its pre-exploitation equilibrium level, and hence fairly near its MSY level, one expects recruitment in median terms to be below its pristine level, It is important to appreciate that that does not necessitate rebuilding – expected recruitment at MSY level will generally be below that at unexploited equilibrium.

The question is how best can the stock be rebuilt,

22) See comments 9) and 21) above – whether there is a biological need for rebuilding has not really been demonstrated.

in a situation where the TAC is dwarfed by other losses (IUU and Cetacean)? The proposal is to maintain a relatively conservative TAC (at least initially) and to maintain *good* protection of substantial areas of toothfish habitat. The accent here is on good – the proposal rests on the assumption that South Africa is prepared to allocate sufficient resources to protect its interests in the Prince Edward Islands. Such a commitment obviously goes beyond the surveillance offered by South Africa's fishing vessels, and will include patrol vessels and perhaps remote sensing.

On the matter of a TAC, the long-term recommendation of no more than 500 tons p.a. by Brandão and Butterworth (2006) allows for a substantially higher catch than the average over the last few years. We also note that a projected 400 ton annual catch does not allow for an increase in spawner-biomass until 2015 (no cetacean predation), or not at all (with cetacean predation), and that a more conservative initial TAC of around 300 tons would be more appropriate for stock-rebuilding.

23) See comment 22) above.

These amounts are still above the recent average catch. There should also be an incentive by way of additional quota for pots, which seem to hold advantages over long-lines in terms of fishing mortality and environmental impacts.

24) Indeed, though regrettably (we understand) this is more than offset by economic negatives in terms of catch per set.

Allowing similar levels of fishing everywhere would not provide any preferential protection to large fish (particularly in the deep areas), and would not guard against the possibility that losses to IUU and cetaceans may be higher than what is currently estimated.

25) For the same TAC, it is not clear how restricting legal fishing in certain areas would make any direct difference to the extent of IUU fishing or of theft by cetaceans.

The comment about large fish is possibly based on recent local arguments (in respect particularly of hake) that larger fish should be preferentially conserved because they produce proportionately more and more viable eggs than a simple linear relationship with their mass might suggest. If this were so, note that longline selectivity is estimated to drop with age (see Fig. 4 of Brandão and Butterworth 2007), so that in some sense this method of fishing is somehow such that a refuge of *the suggested nature is created. However, the argument motivating such "protection" is contradicted by general features shown by marine fish stock-recruitment relationships. These are characterised by a parameter termed "steepness" – specifically this is defined as the proportion of pristine recruitment expected if spawning biomass is reduced to 20% of its pristine level. If the egg effect mentioned above dominated the many others that contribute to the eventual shape of the stock-recruitment curve, recruitment near pristine levels (at which older fish are at their most abundant as a proportion of total biomass) would be much higher than when the resource biomass is reduced through fishing, and hence steepness would be low. However, analyses of stock-recruit data worldwide suggest exactly the reverse – that steepness tends to be high, with recruitment falling only when biomass is reduced substantially, and furthermore that this feature is more strongly evident for longer-lived species (Myers et al., 2002). Thus there is no empirical case supporting protection of larger fish with the aim of enhancing recruitment.*

3. Effect of zoning on catchability and size-selectivity.

The concern that a re-zoning of the ground may lead to changes in size-selectivity and catchability is real, but we note that the fishery has already undergone substantial geographic changes, and that presumable these difficulties already apply.

26) No – because existing OMP developments relate to selectivity over recent years. Reasonable fits to length distribution data can be obtained without any need to postulate a change in selectivity over this period.

This concern is also diluted further by the prospect of developing a pot fishery (which seems advisable in the light of substantial losses to cetaceans). The little bit of pot fishing already done has not settled on any pattern.

27) See comment 24) – unfortunately prospects for further pot fishing seem likely to founder for economic reasons.

4. Monitoring and detection power

Butterworth and Brandão (2007) provide an analysis which suggests low power for detecting changes in CPUE, due to its high current variability (most of which stems from the anomalous 2005 year)

28) No – the calculations were based on CPUE data from within the proposed MPAs, for which such variability is not particularly high (see Fig. 4 of Butterworth and Brandão 2007); the high variability in the 2005 CPUE ratio (outside vs inside the proposed MPAs – Fig. 2 of Butterworth and Brandão, 2007) arises near entirely from data from outside these MPAs.

Their example is based on a 5-year period. A more optimistic result might have been achieved if the objective was to detect a trend over a period equivalent to the typical lifespan of toothfish (age-at-recruitment is 6 years, age-at-maturity 13).

29) The example was intended primarily for illustration of the type of analysis that necessarily must be part of such MPA proposals. The choice of a 5-year period was simply because this period is being quoted for a similar penguin-related exercise locally, and penguins and toothfish have similar M's and hence longevities.

Presumably a recruitment effect will only be detected six years after the first unexploited cohorts have attained maturity, spawned and improved recruitment (i.e.

> 13 years: 7 years to get from t_c to t_m + another 6 years for their progeny to reach t_c). In practice, the build-up of spawner-biomass may take considerably longer if spawning is most effective in old fish.

The difficulty with this fishery is that the period between cause and effect will test most people's patience and will certainly exceed the period of long-term rights. Choosing a more realistic detection period, together with greater stability in the fishery and fish stock (as it rebuilds), will provide for greater detection power.

30) Clearly power depends on the level of variability, the period of observation and the effect size considered meaningful to detect. The primary point here though is that such computations are a necessary prerequisite to be able to claim that the proposed MPAs will "serve as a scientific reference point that can inform the future management of the area" (objective 2) for the PEI MPA proposal, Nel, 2006). More specifically, any such proposal needs in this respect to follow the same best practice as set out at the July 2007 international stock assessment workshop for the planned penguin-fishing experiment, viz.:

C.1 (H*). The general "best practice" guidelines for experimental design outlined below should be followed for any African penguin experiment.

The Workshop highlighted the importance of following a structured approach to developing an experiment attempting to ascertain the effects on penguins of restricting pelagic fishing in the neighbourhood of some penguin breeding colonies so as to ensure that the results can be analysed using standard statistical methods, with the nominal Type I error rate and a predictable Type II error rate. The Workshop noted that power analyses can be quite difficult to conduct when there are multiple covariates so that the use of covariates should, if possible, be avoided when deciding how the results of an experiment should be analysed. The following questions should be addressed when developing experiments (see also Appendix 1):

- *What are the specific alternative hypotheses?*
- *What are the predictions under each hypothesis?*
- *What past data are available for the case under investigation?*
- *What size of an effect would be considered "of consequence" and what is the desirable probability of detecting an effect of this size?*
- *What needs to be monitored to detect an effect?*
- *How can past data inform the amount of process and observation error for each variable that could be monitored?*

We should also consider the value of a benchmark site for size-structure – perhaps as a means to establish, or at least confirm, natural mortality.

31) Again this implicitly assumes that each MPA encompasses an isolated stock, or one has to add the problems of estimating interchange rates to those of the impacts of trends in recruitment and selectivity-at-age as well past fishing mortality, which all confound the estimation of M – this is a highly non-trivial problem.

The latest proposal to use mean size as an indicator in the MP (Brandão and Butterworth 2007) might benefit from developing a range of size-structures under different rates of mortality.

32) The broad idea here is fine in principle, but the success of such experiments rests on a high contrast in treatments between areas (as well, of course, as sufficiently limited mixing), and the proposal as at present is not tailored to that.

We contend that Butterworth and Brandão (2007) have taken a narrow view of the concept of ecological reference areas. In fact the reference areas in this proposal should more correctly be considered as different treatments within the fishery, considering that some exploitation will be needed in the "closed" areas. Different treatments are a means to measure rates and processes that are elusive under a uniform fishing strategy.

The concept of a reference area applies not only to the fishery but also to other elements of the ecosystem for which an undisturbed, or lightly disturbed, area may one day have value for research or monitoring. There have certainly been enough examples of this value in coastal fisheries.

33) The potential value of experimental management (different treatments) as a basis to provide enhanced information, inter alia to aid subsequent management decisions, is certainly supported, but as emphasised above its key pre-requisites (absent in the current proposal) are:

a) sufficient contrast, and
b) prior power evaluation.

Further remarks

There can be no doubt that the toothfish fishery around the PE Islands EEZ has been compromised during a period of intense IUU fishing. The mismanagement continues today. Apart from continued, though reduced, IUU fishing, the loss of an amount equal to double the catch to cetaceans is not only wasteful in the extreme, but may compromise the killer whale populations. Continued interaction between whales and fishermen will almost certainly invite lethal retribution from fishers, and may lead to undesirable long-term changes in whale behaviour.

34) At current legal and estimated illegal catch levels, the maximum theft by killer whales from longlines is about 500 tons per annum, which roughly equals the annual food requirements for about 10 killer whales. Given Antarctic wide abundance estimates for killer whales of some 25000, with some 2000 in IWC Area III (0^o to 70^oE) (Branch and Butterworth, 2001), this would not seem an effect of importance for killer whales, unlike for the fishery.

The proposed marine protected area is an attempt to usher in a more responsible and balanced approach to resource management. Such an approach would seek to restore the toothfish stock to optimal productivity,

35) Current best estimates from assessment place the resource at well above that level – see comment 9) above.

to ensure the conservation of all other species and to protect South Africa's interests. On principle it would seem desirable not to exploit the entire range of toothfish, but to leave some areas in a natural state (this principle has a legal mandate).

36) Whatever some legal instrument might state, the scientific inescapability is that unless the areas concerned contain totally closed populations of toothfish, any fishing of toothfish outside the areas impacts the toothfish abundance inside those areas which are accordingly not left in a natural state.

However, a more pragmatic compromise would see some exploitation in almost all toothfish areas, for the purpose of gaining useful information.

37) Certainly this is a sensible standpoint.

When compared to other fisheries, the toothfish fishery is at a severe disadvantage. It got off to a late but fiery start, most of which is unrecorded and unavailable for assessments. Part of the rationale for the marine protected area is to hasten the recovery of toothfish,

38) See comment 9) above.

and to provide a reference of an unexploited part of the stock. In this regard the MPA is a long-term investment. Spectacular results will not emerge quickly, but rather we can expect a gradual restoration of an ecological balance in at least some areas within decades.

39) Unless the isolated stocks scenario of comment 36) pertains, these comments don't apply.

It is correct that, in a well managed fishery, closing certain areas permanently will result in a below-optimum harvest for any given effort. We see this short-fall as a premium which can be viewed in two ways. Firstly, we should consider the possibility that the fishery will not be well managed (for what ever reason) and that greater protection of certain parts of the range represents a caution against the possibility of losing everything. Secondly, we realise that the fishing industry is one of many interests in the ocean, and that there is a broad societal interest in a healthy ecosystem,

40) This term first needs definition in this context to be meaningful.

which does not consider a policy of fishing everywhere as rational or desirable. Certainly, the track-record of fisheries management in the Southern Ocean adds weight to this recent perspective.

The points raised by Butterworth and Brandão (2007) deserve further attention, and we should not under-estimate the effort that is required. Discussions on the results of such work will inform the operational details of the fishery management in the proposed MPA, but we see no reason to stall the broader proposal for urgent protection,

41) IUU fishing aside (and MPA declaration per se doesn't directly assist to curb that), no case for urgent protection seems to have been made.

which should serve a variety of interests. The greatest concern presently in the light of financial uncertainties is securing the resources to protect this remote area. To this end, we expect that a MPA will serve as vehicle to raise the profile of the PE Islands EEZ,

42) MPA declaration, as any other scientific management measure, should have its justification in the best available science, not in "raising profiles". The latter carries the very real danger of making it easier for decision makers to make decisions irrespective of whether they have, or contradiction to their scientific justification.

and the necessary commitments from government. A business-as-usual approach is unlikely to lead to significant budget-restructuring.

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CONCLUDING COMMENTS AND SUGGESTIONS

A) Although some aspects of the proposal of Nel (2006) for a PEI MPA have been quite thoroughly researched, this does not seem to be the case for aspects related to the toothfish fishery in this region. The response above by Attwood and Nel to Butterworth and Brandão (2007), together with the associated rebuttal comments above, would seem to strengthen the arguments of Butterworth and Brandão (2007) that the proposal of Nel (2006) for a PEI MPA fails to adequately address two of its four stated objectives as they apply to the toothfish resource and associated fishery in the region. The proposal should be placed on hold until reviewed and modified as necessary so that fishery-related objectives are appropriately chosen and the approach to achieve them defensibly motivated. Given that this proposal will set a standard for other possible MPA proposals for waters closer to home, that standard must be set appropriately.

B) Comments made by Attwood and Nel (see comment 9) above) about desired target levels for resource abundance, though perhaps the product of misunderstandings, raise concerns about the intent underlying the WWF MPA initiative in the context of current norms for local fisheries. Furthermore, it is important that best practice procedures for experimental design are followed in developing monitoring schemes associated with MPAs. Broad agreement on these should be sought at a workshop involving interested parties for all local fisheries before the overall WWF MPA initiative moves further.

C) If this has not been done already, any evidence of longline operations damaging corals in certain areas (as is a concern for the South Georgia toothfish fishery) should be taken into account in considering possible MPA placement.

D) Plausible hypotheses concerning stock structure and movement of toothfish need to be identified before discussion on the possible benefits of MPAs to the overall PEI toothfish resource can progress. For example, the distribution of toothfish fishing in the PEI region (see Fig. 1 of Butterworth and Brandão, 2007), coupled to the bathymetry, indicates some disconnected areas of toothfish presence. This is unlike the South Georgia situation, and makes the possibility of stock structure within the PEI region more likely. MPA design should in particular consider how best to confirm or refute such a possibility if deemed plausible, by seeking different treatments of different areas to secure appropriate contrast to provide reasonable statistical discriminatory power. (Note, incidentally, that the current proposed design is quite inappropriate in this context, with the boundaries of the proposed SIR MPA bisecting such connected areas rather than encompassing them.) Any such programme would desirably be linked to a tagging programme to provide information on the extent of toothfish movement in the PEI region, subject to a prior quantitative feasibility study.

E) Implications for industry of any sampling activities within a proposed MPA need to be spelt out in much more detail than in paragraph 3.2.3 of Nel (2006).

F) The most serious problem facing the current toothfish fishery seems to be the economic implications of lowish catch rates. The 1997 catch and effort data merit a closer spatial examination to check the hypothesis of local depletion of density hot spots further (see comment 14) above). If this finds support, it could be that recovery of past density levels in these hot spots could assist the fishery economically though allowing these spots to again be fished but at appropriately controlled effort levels to maintain their higher densities. If some such hot spot positions are found to be in regions close to the islands now closed to fishing, a very limited fishery in these areas should be considered to ascertain whether there is already possible evidence of such recovery. This is notwithstanding the proposal of Nel (2006, section 3.1) that the 12 nm zone around the islands be managed as a no-take zone, given that the associated motivation of protecting juvenile toothfish does not seem particularly strong (see comment 3) above).

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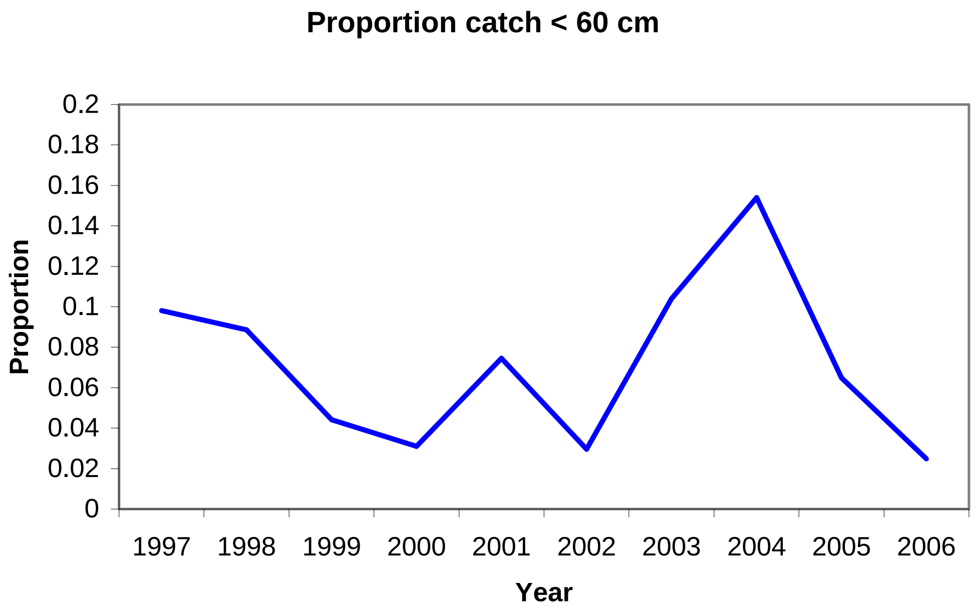

Figure 1. Proportion of longlined PEI toothfish catch that is less than 60 cm in length.

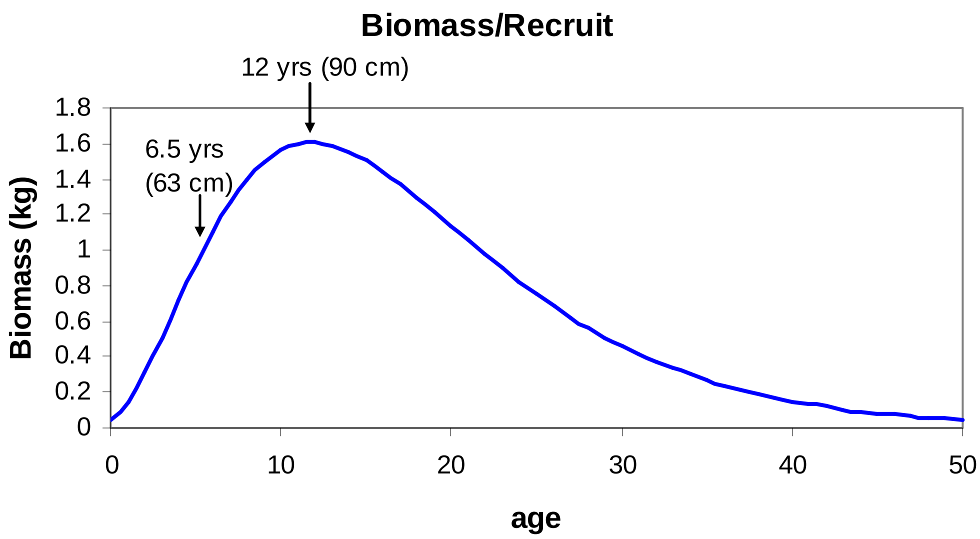

Figure 2. Cohort biomass per recruit for toothfish as a functtion of age.

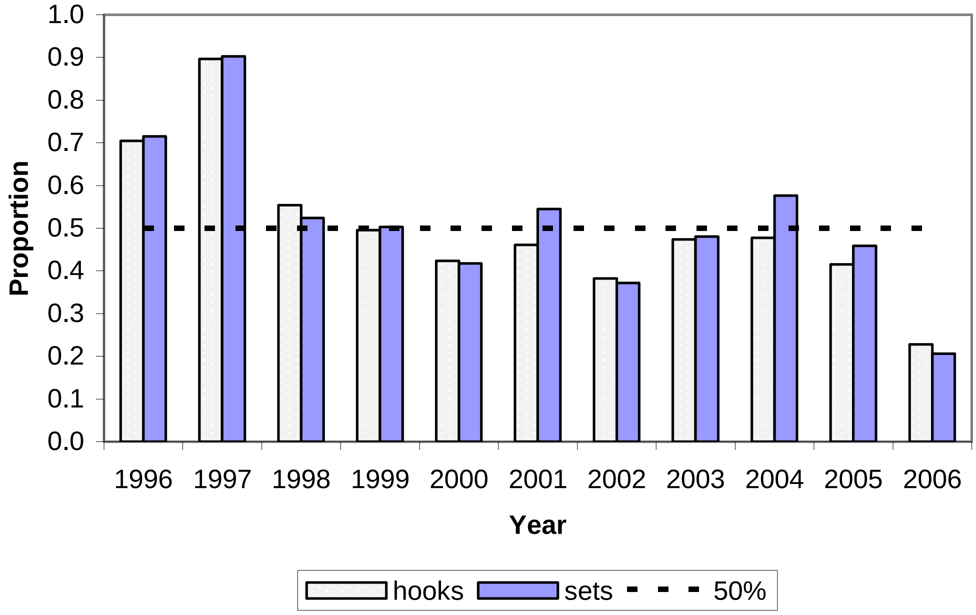

Figure 3. Annual proportion of number of sets and hooks in the proposed PEI MPAs. The dashed line is at 50%. Note that the results for 2006 are unfinalised as data available extended only to April.

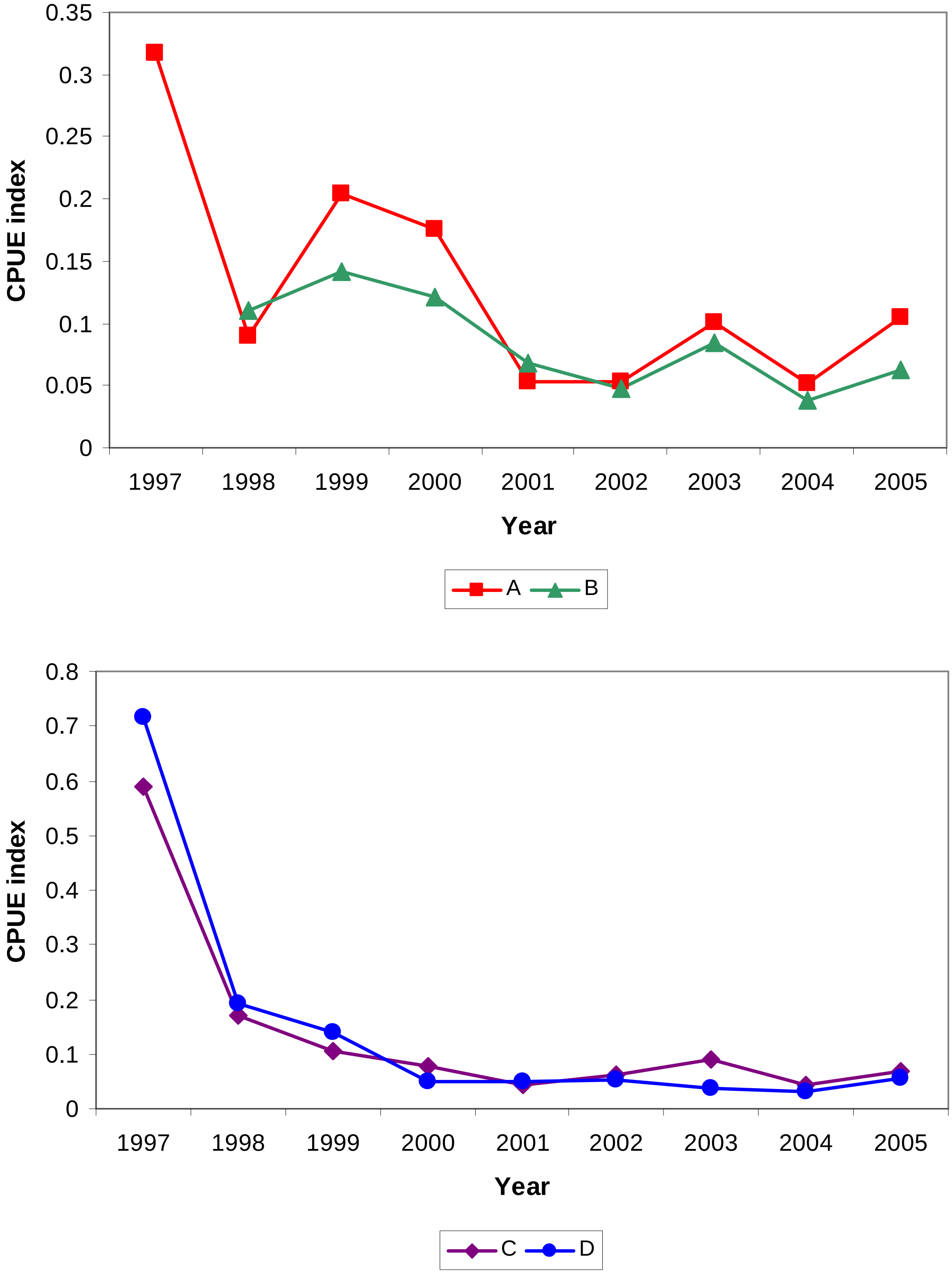

Figure 4. GLM-standardised CPUE indices for each of the four areas into which the Prince Edward Islands EEZ is divided for such analysis. (For a map, see Fig. 1 of Butterworth and Brandão, 2007.)