7-2012

Review of report on the “Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion"

Department of Fisheries

Recommended Citation

Department of Fisheries. (2012), *Review of report on the “Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion"*. Government of Western Australia Department of Fisheries, Perth. Book.

Fisheries Occasional Publication No. 98, 2012

Review of report on the "Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion"

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Correct citation:

Morison, A. K. 2012. Review of report on the “Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion”. Fisheries Occasional Publication No. 98. Department of Fisheries, Western Australia. 52pp.

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Published by Department of Fisheries, Perth, Western Australia.
Fisheries Occasional Publication No. 98, July 2012.
ISSN: 1447 - 2058 ISBN: 978-1-921845-21-5

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1.0 Summary of the review of the draft report

"Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion" Marriott *et al*. 2010.

by Mr A. K. Morison, Morison Aquatic Sciences, February 2011
for the Department of Fisheries, Western Australia

This draft report has been reviewed with the objectives

1. Determine if the assessment advice generated for these three species is appropriate for use in the IFM process given-

   - the data available,

   - specific circumstances of the stocks and the fisheries operation, and

   - the nature of the integrated fisheries management (IFM) process for Gascoyne Demersal scalefish fishery.

2. Provide any additional scientific comment or advice that may be useful to assist with the future monitoring and assessment of these species.

Summary of the findings of the review

The Report is a thorough compilation of the information available on the chosen indicator species. Notwithstanding the suggestions outlined below, I found the assessments that have been undertaken on these species to be generally thorough and innovative in a number of aspects. The advice based on these assessments is sound and appropriate for use in the IFM process.

The Introduction and description of the Gascoyne Marine Environment provide important background but some more information on the IFM process could be useful to readers.

Suggested improvements to the overview of the Gascoyne fishery include the inclusion of a brief catch history for each sector, reporting the most recent status assigned to the indicator species and an explanation of some additional terms.

I had a number of questions regarding the design of the sampling program, the answers to which would give readers a more thorough understanding of the difficulties and limitations of data collection in these fisheries. Additional focus on assessing the representativeness of samples collected would add strength to the assessments and the advice.

I found there to be some gaps in the methods described for assigning ages for all three indicator species but expect that these are unlikely to substantially affect the conclusions from the assessments.

Additional descriptions of the nature of the logbook data and any measures taken to validate it would be useful.

The rationale for the grouping of data by area and months is generally well explained but could be further clarified. There are potential implications for the assessments from the use of different yearly groupings of data for the fisheries (both recreational and commercial) and for assigning fish ages. These should be explored further.

The adoption of different assessment approaches to the different indicator species is an appropriate strategy. It recognises the limitations of the qualitative and quantitative differences in data available for each species and allows for more sophisticated assessments where the data are available to support them.

The assessments undertaken for pink snapper are quite thorough and lead to conclusions that are well supported. Suggestions for future work include increased attention to ensuring representative sampling, considering the benefits of a simpler single-sex model, investigating the estimation of natural mortality within the assessment model, and undertaking and reporting sensitivity tests to alternative inputs or assumptions particularly for different time series of catch rates. Investigation of the issue of post-release mortality would be prudent.

For spangled emperor, the basis for data selection could at least be more clearly explained. There are notes of caution about the strength of the age validation work and the estimates of batch fecundity used in the assessments. The catch curves and yield per-recruit are analysed appropriately with an appreciation of the assumptions behind these methods. There are some questions concerning the interpretation of trends in catch and effort data. Nevertheless, analyses of catch rates (currently contained with an appendix to the report) could be more formally incorporated into the assessment. The identification of post-release mortality as a potential issue is appropriate.

For goldband snapper, there are some issues identified around the methods for estimating age and their precision. The issue of mis-matched years mentioned above may have contributed to this. The analysis of the data on catch and CPUE is appropriate and the conclusions drawn reasonable. The yield per recruit analyses are undertaken appropriately and the exploration of the effect of changing the age at selectivity is worthwhile given available information. The identification of post-release mortality as a potential issue is also appropriate.

The chapter on the general discussion and implications could be improved by including reference to the specific values for the target, threshold and limit reference points. There is some apparent overlap in the criteria tabulated for the weight of evidence approach used for spangled emperor and goldband snapper and the biomass-based criteria used for interpreting the model outputs for pink snapper. There is also some confusing wording in the captions to, and column headings for, these tables.

How the results of the yield per recruit analyses for spangled emperor and goldband snapper contribute to the weight of evidence assessments should be more clearly explained.

Consideration should be given to amending the factors considered in the risk assessments to include a separate group of fishery-related factors. This would identify fishery attributes potentially amenable to change through management intervention, identify the actual sources of risks from each fishing sector, and allow for a formal and transparent re-scoring of risk in the future under proposed or actual changes to the fishery.

Consideration should also be given to combining current risk scores against the suite of factors into an overall risk rating that links to an agreed management response.

2.0 Introduction

This report is a review of the information contained in the draft report by Marriott *et al*. 2010a "Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion", hereafter referred to as the Report.

The complete terms of reference for this review are provided in Appendix 1 but there are two objectives:

1. Determine if the assessment advice generated for these three species is appropriate for use in the IFM process given-

   - the data available,

   - specific circumstances of the stocks and the fisheries operation, and

   - the nature of the integrated fisheries management (IFM) process for Gascoyne Demersal scalefish fishery.

2. Provide any additional scientific comment or advice that may be useful to assist with the future monitoring and assessment of these species.

The draft report provided to the reviewer was accompanied by notes that listed details of further changes proposed to be made to this report upon receiving the revised recreational catch and effort data.

The IFM process that this report informs "seeks firstly to set total sustainable harvest levels for each stock that allows for ecologically sustainable fishing and then allocates explicit catch shares among the commercial, charter and recreational sectors".

To achieve this it was identified that there is a need "to gain a better understanding of the biology of the key target species, determine the current stock status and assess the associated risks to ongoing sustainability".

The three key target species (pink snapper *Pagrus auratus*, spangled emperor *Lethrinus nebulosus*, and goldband snapper *Pristipomoides multidens*) comprise the indicator species used in a weight of evidence approach to assess the status of the suite of species caught in the fishery. This review, therefore, focuses on the quality of the data, the assessments for these species in which these are used and the validity of the conclusions drawn from them. Comments are also provided on the assessment framework used to assess risk to stocks of the indicators.

3.0 Report Review

This review generally follows the same structure as the report, with each section (methods, biological characteristics, fishery characteristics and stock assessments, etc.) dealing with each of the three indicator species in turn.

3.1 Introduction

This section is generally clear and concise and describes the purpose of the report and how the results will be used in the broader assessment framework.

At least a brief description integrated management framework (IFM) that this report is informing would also be useful in the introduction. While this may be well known to those in WA, an outline of the process and how the information contained in the report contributes to it would be useful. The references currently cited (Anon 2000a, Fletcher *et al.* 2010 and Lenanton *et al.* 2006) do not provide this overview.

3.2 The Gascoyne Marine Environment

This section provides a useful and concise overview of the area covered by the report and a link to more comprehensive information available in other sources. There is, however, some management information presented here (on Offshore Constitutional Settlements) that may be better placed in the next section.

3.3 The Gascoyne Fishery

The overview of the different sectors in the fishery is useful but could be better titled as 'management arrangements for the Gascoyne fishery'. A general summary of a fishery would normally be expected to include at least some history of catches and such an overview here would give the reader an indication of the scale of the fishery, but any mention of catch levels is left to Chapter 6 where the data are analysed and discussed in detail.

There are, however, some mentions of relative catch levels (e.g. 'small catches of these species are also taken as byproduct', 'very small catches of larger individuals of pink snapper and mulloway taken by trawling' and 'small quantities of pink snapper have been retained in the inner gulfs') which leave the reader wondering about scale of these catches. These statements could be augmented by a brief summary of recent catches by the sectors or (less preferably) a reference to where these data are available (such as in the most recent State of the Fisheries Report).

Where available (only for Shark Bay pink snapper?) a summary of the most recent status assigned to each of the three target species in the State of the Fisheries report would give an early indication of the stock status and help set the scene for the rest of the report. Also, any inability to assign a status to a key indicator species would be a point worth raising in the introduction under 'Need'.

Some explanations of terms could assist here as well. The term 'mechanised handlines', for example, sounds like an oxymoron. Does this just mean a powered reel? And also what are 'wetline vessels'?

3.4 General Methods

Sample collection

It is mentioned that no samples of oceanic pink snapper or goldband snapper were obtained from the recreational or charter catches as part of the study. This seems like a potentially serious omission but the need for such samples will depend on the relative catch by these sectors. Some comment in this regard would be useful.

Some comment on the basis for sampling by fishery-dependent and fishery-independent methods would be useful. Fishery-independent samples are often preferable but more expensive. Were they only used when fishery-dependent information wasn't available? Were they used to get different sorts of information?

Other questions about the sampling program are –

- Have the collections been made with some specific target samples sizes in mind?
- Is it possible to develop and implement such a target or are most samples collected in an ad-hoc manner?
- What measures are taken to ensure that, or examine whether, the fishery-dependent sampling is representative of the fishery?

This final question is potentially very important, as the reliability of an assessment may be seriously compromised if the data used are not representative of the fishery (for fishery-dependent data) or the desired component of the stock (for fishery-independent data).

For an assessment based on an age-structured model, such as is used for pink snapper, a two-staged sampling approach is often used whereby the lengths of many fish are measured and the ages of only a subsample are determined. This approach may be preferred because length data are usually relatively cheap and easy to obtain whereas age data are expensive. Both data types may then be used as inputs to the assessment model or the age composition estimated outside the model by applying an age-length key to the length-frequency data. Such a two-stage approach is often a more efficient way to characterise the catch. For pink snapper it is possible that length and age are obtained for every fish sampled but it is not clear whether this is the case or whether a two-stage sampling framework would be more efficient.

Sample processing

The description of the methods used for age determinations for all three indicator species are incomplete within the report. Detail on methods used to assign ages to increment counts should be included in the report.

The PhD theses cited as containing the details for pink snapper (Wakefield 2006 and Jackson 2007) and are not readily accessible to most readers and do not allow others to replicate the methods used or readers to assess their appropriateness. Information subsequently provided by Dr Jackson (pers. com.) indicated that for pink snapper birth dates used in assigning ages to individual fish were either 1 June or 1 August depending on the particular stock. This choice of birth date, although ensuring that the transition of one age class to next coincides with the timing of spawning and increment formation, does not match with the assessment time step which groups other data on a calendar year basis.

The potential implications of this mis-match are outlined below and discussed in more detail in Appendix 2.

For spangled emperor, the paper cited as containing the details about how increment counts were converted to ages (Marriott 2010c) contains the information on the selected birthdate (Oct 1) but refers to another paper (Marriott 2010b) for more details. This other paper, however, has only one sentence on the methods: "Fish that were sampled during the period of peak opaque increment deposition (1 October to 31 December) that had wide translucent otolith margins were assumed to have late forming opaque zones and the estimated age classes of these fish were the number of opaque increments counted plus one." There is no mention of how samples with different margin types or caught outside this period were treated. For example, the substantial proportion of fish caught before the assigned birthday of October 1 already with an opaque margin were assigned an age should be assigned an age one less than the number of opaque increments. The combination of the two papers, therefore, does not contain a complete description of the methods used.

For goldband snapper the reference cited as containing details on how increment counts were converted to age estimates (Newman and Dunk 2003) contains no description on this process although at the assigned birth date (1 April) edge types are shown to include narrow opaque, wide opaque and translucent margins – which indicates that some algorithm is needed.

Logbook data collection

More detail on the nature of the commercial logbook data collected would be useful. The reports are provided monthly but it is not clear if these monthly reports include data at the level of individual shots or days or just monthly totals. Some description of any quality control measures that are used to validate data would also be useful, as would mention of any studies that have attempted to compare logbook data with other measures of the catch (e.g. observer data or market data).

More information on how the data collected from the recreational sector, particularly the data provided by volunteers in the Research Angler Program, is used in assessments should be included. Providing the objectives of such data collection programs would be a start. Voluntarily provided data is prone to a series of biases (as discussed in an earlier review by Dr Steffe) that may limit its usefulness for stock assessment purposes.

Analyses – rationale for spatial and temporal grouping of data

This section outlines the issues that arise from having data from the commercial and recreational sectors that have been collected over different time periods. It is not made clear in this section, however, how the issue was finally resolved. There is mention that ' data for the commercial year 1 September 2006 to 31 August 2007 were compared to data for recreational and charter years commencing 1 April 2007 ending 31 March 2008'. It is not stated, however, whether the data are used in the assessment (for pink snapper) with this mis-match of years or, if so, why. If the commercial data are provided monthly it would seem relatively easy to regroup it onto the same yearly basis on which the recreational data are available. In the assessment there should at least be an assessment of the sensitivity of the results to different ways of grouping the input data. It may make little difference to the final determination of stock status but it would be prudent to at least examine the potential effect.

There is an additional issue over the temporal grouping of these data that has not been examined. This concerns an additional mis-match between the years used for the commercial and recreational data, and those used in the assigning of fish ages, based on the birth dates. The details of this issue have been the subject of an email exchange and phone calls with Dr Jackson but a summary of the issues is contained in Appendix 2. The implications for the assessment depend in part on the allocation of samples among months and how much this varies from year to year. This could not be assessed from the information available.

Analyses – Rationale for adopting different assessment approaches for the different indicator species

This rationale is well explained and logical. It is sensible to tailor an assessment approach to the types of information available and its quality. What is not clear from this section, however, is whether the much simpler form of assessment used for spangled emperor and goldband snapper will also require a more precautionary approach in the determination of appropriate catch levels. A more precautionary approach for these species would assist in keeping the overall risk levels similar across assessment types. Management measures based on the more quantitative assessment used for pink snapper, based on a broader range of data sources, would be expected to provide a lower risk that catch levels set in accordance with the results of the assessment would in fact constitute overfishing.

3.5 Biological characteristics of key indicator species

Pink snapper

The distribution of pink snapper could be more clearly specified as around southern Australia as the current wording is ambiguous and the limits to the distribution in Queensland and WA could be interpreted (admittedly only by those with limited knowledge of the species) as the southern limits of a tropical distribution. The knowledge of the detailed structure of pink snapper stocks in this area is impressive and strongly supports the need to treat these adjacent areas as comprising separate stocks.

The number of samples obtained (Table 5.1.1) is generally good for the oceanic stock in recent years but there are troubling gaps in earlier years (pre 2003). The sample sizes for the Inner Gulfs, however, are quite variable and marginal in many years. Nothing can be done about this for past years but efforts should continue to be made to improve the number of fish sampled in the future.

The potential biases in the ageing data are well assessed. It is stated that "no significant trend in bias was evident ... from the most recent year" and the agreement between readers is generally very good, but Figure 5.1.1. suggests some bias in the ageing of the youngest two age classes in Denham Sound and Freycinet that should be examined further.

In fitting growth curves to the sexes separately I could see no reference to how samples from immature fish whose sex could not be determined were used (if there were any in the samples). Often these are allocated randomly to either male or female samples to keep the data sets independent.

There are statistically significant differences in growth between the sexes estimated for two areas but not for the other two areas. The two areas with significant differences (oceanic and Denham sound) are also the two areas with the worst fits to the data (R^2 <0.9) and for the oceanic stock the estimated L_{∞} value is much less than the observed L_{max}. The actual fits of the curves to the data are not shown but it could be questioned whether there are biologically important differences in growth between the sexes. Consideration could be given to the use of a single sex model as any increased realism from implementing a sex-structured assessment could be more than offset by the increased number of parameters needing to be estimated from smaller datasets through having to split them for males and females.

Estimates of natural mortality are an important part of age-structured models. The methods used to provide initial estimates of mortality for pink snapper are rigorous but, as mentioned below, an alternative may be to use an assessment model that also estimates natural mortality as part of its parameter fitting process.

The patterns of recruitment for the Freycinet stock suggest that the 2000 cohort is the most dominant (Figure 5.1.5), but the actual age composition plot (Figure 5.1.3) indicates that 1997 cohort was much stronger. Commentary on the reason for this apparent discrepancy would be useful.

The methods used and results for the various reproductive aspects are appropriate and well explained.

The discussion of the issue of discard mortality is important and the conclusion that it is likely to be a significant source of mortality is sound. Work to further quantify this mortality and to use the results in future assessments should be explored. It is unclear whether discards are currently factored into the assessment.

Spangled emperor

The variety of sources of samples raises questions about what constitutes a representative sample of the recreational fishery. The choice to use only samples from boat ramp surveys combined with donated samples as the 'representative sample' is essentially arbitrary but not necessarily wrong. For the South Gascoyne the length-frequency distributions from the ramps, roving creel surveys and donated were not significantly different from each other (according to Marriott *et al.* 2010b although this analysis did not include samples from the charter sector or fishing tournaments) and presumably all samples could have been pooled in this region. The distributions from the charter sector or tournament samples do not seem to have been included in the pooled "representative" sample but in Table 5.2.1 these data are shown in bolder text which implies that they were '"used in/considered for analyses".

There may be other defensible ways to use these additional data (e.g. through some catch-weighted combination of the samples) but at least the sensitivity to including or excluding the data could be explored. The choice of which data to include is difficult but generally all should be included unless there is some *a priori* reason to prefer one data source over another.

The validation of the age estimates in the Marriott *et al*. (2010a) paper is relatively weak being entirely based on edge type analysis. This analysis shows that all edge types are found in all months across the sampled period with substantial variation between years in proportions of edge types in particular months. It is also not stated whether the reader determining the edge type knew the month of sampling at the time of reading (a potential source of bias with this validation method), but judging by the variability in the proportions it would appear not.

The analyses of growth curves are appropriate and the differences in growth between regions are substantial. The inclusion of statistics for males and females for the combined regions (Table 5.2.2) seems inappropriate given that it has already been found that the growth is different between the two regions.

The reproductive studies are well described and comprehensive. The batch fecundity estimates, however, show a surprising range (almost two orders of magnitude) and an increased sample size with a wider range of sizes and ages may provide a more precise estimate of this parameter.

The identification of post-release mortality as a potential issue is appropriate. Information on the size composition of the released component on the catch should be combined with estimates of post-release mortality to explore their potential influence on the assessment.

Care should be taken to show consistency in the descriptors used for life history parameters. In Table 5.2.4 spangled emperor are described as having a long lifespan which matches the definitions in Table 7.3. When discussing ageing precision, however, both pink snapper and goldband snapper are described as being of moderate longevity but both also have maximum ages of at least 30 years. For goldband snapper F:M ratios are said to be "related to pre-determined reference levels developed by the DoFWA for long-lived (longevity exceeding 10 yr) species". The use of such terms should be consistently used or avoided and values quoted.

Goldband snapper

Table 5.3.2. reports 'precision' values but it would be helpful for some explanation in the text as to what an acceptable level of precision is, especially as another measure of precision, the average percent error, is used elsewhere for judging the suitability of data on catch at age.

The precision of otolith readings was reported by Newman and Dunk (2003) to be "very high" but the average percentage error of 10.4% suggests a marginal level of precision. The average percent error in the report for the sample from South Gascoyne (1.45%) is a much more acceptable result.

Validation ageing data is attempted using a relatively small sample size and sampling period and adds little to the more comprehensive results reported for an adjacent area in Newman and Dunk (2003), although this study itself suffers from the limitations of an edge type analysis.

The lack of modal progression in the two aged samples of goldband snapper (2005/06 and 2007/08) indicates that one or more of the following has occurred in at least some years: the ageing is inaccurate, the samples are unrepresentative, or the samples come from different stocks. Some discussion of the likelihood of these options would be useful. On the first possibility if the ages were assigned based on an April 1st birth date (as used in Newman and Dunk, 2003) and these age compositions have been grouped on a September to August fishing year, the observed differences could be attributable to differences in the months in which the majority of samples were collected in the two years (before April in 2005/06, after April in 2006/07). This may be an example of the year-class smearing discussed in Appendix 2.

The potential for post-release mortality to become an issue if a MLL was introduced is acknowledged. Whether there is already any discarding in the commercial fishery for other reasons, however, is not clear.

3.6 Fishery characteristics and stock assessments

The grouping of species in catch and effort returns (for spangled emperor and goldband snapper) is a significant problem for any assessment that uses commercial catch and effort data, especially if there are no data on how the species composition has varied over time. Presumably the data used for the assessments are from samples for which the species identity is not in question but this issue should be clarified.

The spatial aggregation of commercial catch data is understandable for the report but hopefully finer scale data are able to be used in the assessment. It could be important to know the extent to which the commercial fishery (both catch and effort) overlaps with the centres of activity for the recreational fishery. Are the areas fished just those that are closer to ports or does the distribution of effort reflect where the target species are found? Some statistics on the amount of overlap between the sectors could be reported presumably without breaching confidentiality requirements.

Rotating all the maps of catch and effort would make them easier to read, especially in the final printed version.

I found the structure of this chapter of the report in particular made it difficult to follow. It presents information on effort, catch, catch rates and assessments separately for each species. In my view it is easier to get the picture for a particular species if all the relevant data and the assessment results are considered together especially given that the types of input data and assessments differ so much. Readers (such as this reviewer) are more likely to want to cross-reference among data, results and conclusions for a particular species than among species. Therefore, in the review of this chapter I deal with the methods, data and assessment together for each species.

Oceanic Pink snapper

The different methods of analysing the commercial catch rates for pink snapper show similar trends but the currently preferred 'Moran' method shows the least decline over the period shown. It would be prudent to examine the implications for the assessment of the other catch rate series being the more representative of the stock, as they may produce more pessimistic but still plausible outcomes.

The DFWA GLM method is said to include the catches of species other than pink snapper, presumably in an attempt to deal with issues of targeting. This approach carries the danger of confounding trends among the different species. Other ways to identify targeted effort should be explored.

The catch rate trends for the 'Moran method' shown in Figure 6.2.3 is labelled as extending to only one year more than Figure 6.2.1 (2006/07 vs. 2005/06) but seems to contain two extra data points and needs to be checked.

The integrated assessment model is reported to have been independently reviewed and modified as a result, which is a commendable initiative, but it would be even better to know if all the suggested improvements have been made.

Recruitment deviations were estimated from the first year of age composition data but it may be possible to extent this series back in time as, for a fish of this longevity, the age composition contains information on earlier recruitment events. The variance on the estimates can also be used to determine the earliest year for which such estimates are reliable.

In the plots showing assessment results (e.g. Figure 6.3.1), it would be clearer if the projected biomass and F values are distinguished from those that have been estimated from the data. The basis for making the projections should also be explained (e.g. what catches were assumed to occur?)

To avoid ambiguity it would also be preferable if axes were labelled with the fishing years e.g. 2007/08 rather than 2008. Or the abbreviation should at least be made explicit in the figure captions.

The assessment for the oceanic stock is reasonably thorough but a range of sensitivity tests to alternative inputs or assumptions what would greatly add to an assessment of its robustness.

The outputs show confidence intervals but these are presumably under the assumption that the model structure is correct and will underestimate the true level of uncertainty in the assessment. Values for key measures of interest, such as shown in Table 6.3.11, that would be estimated for different weightings to data series, alternative CPUE series, different levels of M, etc. help to assess how internally consistent the model is and whether there are any fundamental conflicts between different data sources.

Inner gulfs pink snapper

Several of the comments above on the assessment for oceanic pink snapper are also pertinent to those for the inner gulfs.

For the inner gulfs, the need to use the DEPM estimates as the index of abundance leads to a highly uncertain assessment given the wide confidence intervals attached to these estimates. At first I was puzzled as to why the estimated biomass trajectory passed through the error bounds of relatively few of these biomass estimates (only 14 of 22 estimates across the three stocks) but then I realised that the error bars were +/- 1 SD not 95% confidence intervals. The caption to Figure 6.3.5 should be explicit on what the error bars represent. The same comments about the value of sensitivity tests apply to this assessment. Given the imprecise estimates of biomass, the 95% confidence limits on the model and projections are also an underestimate of the true uncertainty in this assessment.

The assumptions behind the projections used to estimate the time to reach target levels should be more clearly spelt out. I presume that recruitment was estimated from the SR relationship but what catch levels were assumed?

Spangled emperor

The formal assessment of whether samples have sufficient precision to be useful in catch curve analyses is a good approach in principle but I am not familiar with the method used (from Craine *et al*. 2009) and do not feel qualified to comment on its robustness.

The different methods of estimating total mortality produce very different results with different conclusions regarding the ratio of current fishing mortality to natural mortality. The use of different methods and bootstrapping to calculate confidence intervals provide an indication of the variation in the potential range for the relevant parameters. Without a formal analysis of the potential biases in the different methods, however, it is difficult to know *a priori* which approach is more likely to provide the more robust estimate.

CPUE is discounted as an index of abundance for spangled emperor because it ‘has not been a consistent target species’. CPUE may still index abundance, however, if there has been a similar ratio of target to non-target fishing over time. Also, a valid index might still be derived if another variable or combination of variables were themselves indicators of targeting (season, area or vessel). The inclusion of plots of catch rates and an Appendix with more detailed analysis suggests that some at least believe there is useful information in catch rates for spangled emperor. The comment on the suite of other factors that are known to potentially influence catch rates (other than the abundance) is, however, a well made cautionary note.

The catch of spangled emperor by charter fishers is said to have decreased slightly from 2001/02 to 2007/08 but figure 6.1.18 shows no catch prior to 2002/03.

It is stated that ‘there was a large reduction in effort in the North Gascoyne from 91/92 onwards, which was concomitant with the commencement of the Pilbara Trap fishery’. The implication is that there was a shift in effort from one fishery to the other but Figures 6.1.4. and 6.1.5. show the decline in the wetline fishery effort starting earlier (from 84/85 in Zones 5 and 6 and from 87/88 in Zone 7) and the level of effort in the Pilbara Trap fishery is relatively small compared to the sudden drop after 90/91.

It is also said that it is 'highly likely' that declines in catches and catch rates in the North Gascoyne have been caused by changes to management arrangements that prevented fishing in a number of areas. Some detail of the basis for this belief would be useful. What proportion of the previously fished area was closed? What proportion of the catch came out of these areas? What were the catch rates in these areas compared to areas that have remained open? How has effort in the open areas changed?

There are different ways that the proposed effect could happen. It could simply be that the closed areas had higher catch rates and once these are excluded catches and catch rates will decline (regardless on any effort shifts). Closed areas could also lead to significant increases in effort in the remaining open areas causing localised depletion of stocks or gear competition, both of which might lower catch rates (but not necessarily total catch). The reasons are important because they do influence how indicators could change and hence how stock status is assessed.

It is hard to look at the relevant effort trends because the effort data are grouped differently (Zone 1 and Zone 3 individually and Zones 2 and 4 combined) to the catch and catch rate figures (Zones 1 to 4 combined) and effort for all the gears are shown in the one stacked plot. It would be worth plotting the effort data relevant to each catch rate index along with the catches.

The initial drop in catch rates from 75/76 to 80/81 for South Gascoyne is quite dramatic. A rapid increase in effort is proposed as a possible explanation but this only makes sense if it was the cause of a fish-down of a previously unexploited stock; this possibility should be mentioned.

The analysis of spangled emperor CPUE presented in Appendix 2 seems to be a valuable advancement on the catch rate trends presented in the body of the report. It is unclear why it has been relegated to an Appendix. It suggests that the decline in the raw catch rates in North Gascoyne underestimates the true decline in spangled emperor abundance. For the South Gascoyne, the trends look to be more similar. Comparisons are difficult, however, without the different time series being graphed together.

Reasons for the differences in the size compositions between Charter vessels and Recreational fishing should be explored further once the revised effort information is available. More information on the differences in the areas fished and gear used would help back up the statement that these are possible reasons for the observed difference.

The use of catch curves and yield per-recruit analyses are well accepted ways of assessing the impact of fishing on target populations. They are applied appropriately here (and for goldband snapper) with an appreciation of the assumptions behind these methods.

The conclusions drawn are justified by the assessments conducted with caveats given.

Goldband snapper

The analysis of the data on catch and CPUE is appropriate and the conclusions drawn reasonable.

The results of the different methods of catch curve analyses are more consistent for this species than for spangled emperor but the same questions about which is the preferred method still apply. The conclusion that this fishing has had no detectable effects on the population age structure is nevertheless reasonable given the analyses and reflects the relatively large numbers of older fish still present in the population.

The yield per recruit analyses are undertaken appropriately and the exploration of the effect of changing the age at selectivity is worthwhile given available information.

Discussion

This section is more of a summary of the results chapter than a discussion of the findings – which is in the next chapter – and could probably be more accurately titled as such.

3.7 General Discussion and Implications

Table 7.1 outlines the suggested management actions (in general terms) under different combinations of status for fishing mortality and biomass indicators for species where estimates of both these parameters are available. It would be helpful to include in this table (or in the text of this section) the specific values for the target, threshold and limit reference points for both biomass and fishing mortality. These are provided elsewhere in the report but would aid in understanding the decision rules to have them listed here also.

Tables 7.2 and 7.3 are both described as 'weight of evidence assessments' but Table 7.2 covers the situation where estimates of biomass and fishing mortality are available. In such a situation a weight of evidence approach should not be necessary, unless it has been decided that other indicators should be used even when assessment models provide estimates of these parameters. If this is the case then any additional indicators selected should not include those where the data used to derive them may have already contributed to the original assessment (e.g. growth, natural mortality, or as shown in Wise *et al*. 2007, catch, effort, age/length distributions). To do so would give double-weighting to such data.

Despite its title, Table 7.2 seems to represent bases for decision rules that are not weight of evidence approaches. Each of the levels of information presented (biomass, fishing mortality and catch rates/catches) can be, and are elsewhere, used in decision rules on their own. For example, one of the methods of estimating fishing mortality for spangled emperor and goldband snapper is very similar to that currently used to recommend catch levels for 'Tier 3' species in the South East Scalefish and Shark Fishery (Wayte and Klaer 2010). Similarly, catch rates are used in a decision rule for 'Tier 4' species (although not without many points of contention, from both scientists and industry, about the validity of the approach). There have been a range of benefits from the adoption of a set of decision rules for all levels of available data in this fishery (Smith *et al.* 2008).

Assessments based on estimates of biomass and fishing mortality provide measures of different aspects stock status. Fishing mortality estimates can only say whether the current rate of harvest is likely to constitute overfishing whereas biomass estimates can help say whether a stock has been overfished or not. Both measures are important and could be more clearly linked to the indicators and selected reference points. The term overfishing is currently only used in reference to the results of the yield per recruit analyses.

For spangled emperor and goldband snapper, for which estimates of fishing mortality have been derived, it seems that the estimates for these particular species are not considered to be robust, and are apparently regarded as unsuitable for use in the decision rules for fishing mortality as outlined in Table 7.2. If this is the case the reasoning for this decision was not readily apparent.

I found the caption to Table 7.3 to be confusing and think it could do with some re-wording. The column headings are also confusing because they do not describe the column contents but represent the level of management intervention proposed under the situations described. The table represents criteria for scoring the relative vulnerability of a species to fishing for six different factors; the headings represent the step taken after the risk has been evaluated.

Care should also be taken to define the criteria used in the table of current status and vulnerabilities to ensure that they are not correlated. If they are correlated there is the potential for double-counting and a possibly unintended over emphasis on some characteristics. Maximum age is related to natural mortality and growth which are probably all related to vulnerability to fishing and rates of recovery after depletion.

Table 7.3 focuses on the inherent characteristics of individual species but in assessing the risks that a specific fishery poses to a stock there is also benefit in considering (separately) some attributes of the fishery e.g., does it operate over the entire range of the species, does it target aggregations, and does it catch immature fish? These are especially important aspects to include in an assessment because they are the only factors that are potentially amenable to change through management intervention. Including fishery specific factors in the risk assessment is desirable because the source of any risks should be identified as part of a risk assessment process. Once included such factors also allows for a formal and transparent re-scoring of risk under proposed or actual changes to the fishery (in gear used, areas fished, level of effort etc.). A two axis approach (species characteristics and fishery attributes) is described in the approach used for risk assessments in NSW (Astles *et al.* 2009 and papers therein) and is also being employed for assessing risks posed by fisheries in Queensland. Fishery characteristics are included in one of the three broad groups of categories used to select indicator species, and are described in detail in the report reviewed here, but they do not seem to contribute formally to the risk assessment.

There is potential benefit in adding a further step after the scoring of the risk against each of the vulnerability attributes for spangled emperor and goldband snapper to provide an overall risk score. Tables 7.4 and 7.5 score each stock and species against the criteria but there is no attempt to combine these scores. This may be a deliberate decision but the additional step would be useful if these scores are to lead transparently to the proposed management responses. For example, pre-specifying how many high scores are needed before a high reduction in fishing effort is deemed to be required, and what spreads of scores leads to a medium reduction in fishing effort, could assist in avoiding extensive post-assessment debates and lobbying when management responses are proposed.

There seems to be a disconnection in the risk assessment method as Tables 7.4 and 7.5 do not use the same factors as those listed in tables 7.2 and 7.3. For example age/length distributions and effort/catch have been added. Catch rates are listed in Table 7.2 but are not mentioned in the risk tables.

The rest of this chapter provides a good summary of the findings presented in the report from the assessments undertaken and the implications for management under the agreed decision rules and for the future monitoring of the stocks.

3.8 General conclusions of the review

The Report is a thorough compilation of the information available on the chosen indicator species. Notwithstanding the comments and suggestions provided above, I found the assessments that have been undertaken on these species to be generally thorough and innovative in a number of aspects. The advice based on these assessments is sound and appropriate for use in the IFM process.

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5.0 Appendices

5.1 Appendix 1. Terms of Reference

Terms of reference for the review of stock assessments for the three indicator species for the Gascoyne Coast Demersal Scalefish Fishery.

Scope

To review the scientific advice provided in the draft document, "*Biology and stock status of key inshore demersal and indicator species in the Gascoyne Coast Bioregion*", which is being generated to support the Gascoyne Integrated Fisheries Management process for the Department of Fisheries.

Background

The three major species targeted by commercial and recreational fishers which will be used as indicator species for the Demersal Suite in the Gascoyne Coast Bioregion are:

- pink snapper (*Pagrus auratus*; Sparidae),
- spangled emperor (*Lethrinus nebulosus;* Lethrinidae)
- goldband snapper (*Pristipomoides multidens*; Lutjanidae).

Objectives

1. Determine if the assessment advice generated for these three species is appropriate for use in the IFM process given-

   - the data available,

   - specific circumstances of the stocks and the fisheries operation, and

   - the nature of the integrated fisheries management (IFM) process for Gascoyne Demersal scalefish fishery.

2. Provide any additional scientific comment or advice that may be useful to assist with the future monitoring and assessment of these species.

Operations

Department staff will be available for the reviewer to answer questions pertaining to any aspect of the stock assessments (e.g. data collection, data processing, analyses, spatial dynamics, fleet behaviour, management objectives). If required, any relevant data can be provided.

Report

In addition to the formal report, the reviewer is to provide a brief "stand alone" report which explains the conclusions in a format that can be understood by key stakeholders (i.e. members of the Integrated Fisheries Allocation Advisory Committee, IFAAC).

Extension

As the Department of Fisheries will be the client of the review, DoF will have sole responsibility for managing any subsequent extension of the results of the review to interested parties.

5.2 Appendix 2. Implications of a mis-match between an assessment year and fish birth dates

With a birth date of either 1 June or 1 August, as used for pink snapper, for otolith samples collected before the birth date with a narrow margin (showing an early increment) the assigned age should equal the increment count less one, for samples collected after the birth date with a wide margin (late increment) the assigned age should equal the increment count plus one, and for other combinations the assigned age should equal the increment count. This is the standard method of application of birth dates.

To examine the implications of the mis-match of assessment year and birth date consider a cohort spawned in 2000, with age assigned using a 1 June birth date and with a calendar year assessment year.

The age structured model will expect track the abundance of this cohort of fish as its members progressively age across sequential years. It will expect that the 4 year olds when sampled in 2004 are from the same cohort as the 5 year olds sampled in 2005 etc.

Fish from this 2000 cohort sampled in May 2004 would still be only 3 year olds and should be evident in the annual age composition data as such. If they were next sampled late in August 2005 they would be 5 year olds (having passed through both the June 2004 and 2005 birth dates). There would be a two year jump although the data would be shown as from only one year later.

Alternatively, if they were sampled in August in 2004 as 4 year olds and again in May 2005 they would still only be 4 year olds (having not passed another 1 June birth date yet), although again the data would be presented to the model as from a year later.

If samples were obtained from both before and after the birth date, then the age composition for the 2004 year would show both 3 and 4 year olds and for 2005 both 4 and 5 year olds, although they were all in fact part of the same 2000 cohort.

Thus to accurately represent the abundance of a particular cohort for the assessment, the timing of the break in the assessment year and the fish birth date should align.

This is not necessarily a problem depending on the timing of the sampling in the year and whether this varies from year to year.

If all the sampling always happens before or always after the birth date, the age compositions will be correct and show the correct age progression.

If the proportion before and after is always the same there will be smoothing of year class strength (strength of strong cohorts will be underestimated, and weak cohorts overestimated) but the final assessment results may be tolerable.

If the proportion before and after changes markedly from year to year, however, the age compositions will show misleading patterns that an assessment model may not fit very well. The impact on the assessment will be unpredictable.

6.0 Department of Fisheries responses and actions to the review

1. Introduction

The draft report provided to the reviewer was accompanied by notes that listed details of further changes proposed to be made to this report upon receiving the revised recreational catch and effort data.

AGREED. ACTION: SADA Branch (Stock Assessment and Data Analysis Branch of the Research Division) are currently reanalysing the recreational catch and effort data. SADA will be consulted to determine if the additional data summaries and analyses will be included in this report or within a separate SADA Gascoyne recreational survey research report released at a later date. Text in the stock assessment report will be modified as appropriate.

2.1 Introduction

At least a brief description of the integrated fisheries management framework (IFM) that this report is informing would also be useful in the introduction.

AGREED. ACTION: More detail will be added to the description of IFM framework

2.2 The Gascoyne Marine Environment

This section provides a useful and concise overview of the area covered by the report and a link to more comprehensive information available in other sources. There is, however, some management information presented here (on Offshore Constitutional Settlements) that may be better placed in the next section.

AGREED. ACTION: Information about the Offshore Constitutional Settlements (OCS) (i.e. the last 2 paragraphs of the "Gascoyne Marine Environment") will be moved into section 3.1 (under commercial section – now called "Gascoyne Fishery and Management Arrangements").

2.3. The Gascoyne Fishery

The overview of the different sectors in the fishery is useful but could be better titled as 'management arrangements for the Gascoyne fishery'.

AGREED. ACTION: The section will be re-titled to "Gascoyne Fishery and Management Arrangements" and the text modified accordingly.

A general summary of a fishery would normally be expected to include at least some history of catches and such an overview here would give the reader an indication of the scale of the fishery, but any mention of catch levels is left to Chapter 6 where the data are analysed and discussed in detail.	AGREED. ACTION: Table 4.1 will be moved to this section to allow the reader a context of the scale of the fishery by sector. Section 3 was intended to give reader a broad overview of the fishery, while the history of catches is dealt with in detail in Section 6, as the reader needs to relate catches to the assessments of each species in the same section. This is actually a suggestion by the reviewer (page 8 of the review, paragraph 3). In addition, statements will be added referring to the text of Chapter 2 as appropriate.
There are, however, some mentions of relative catch levels (e.g. ‘small catches of these species are also taken as byproduct’, ‘very small catches of larger individuals of pink snapper and mulloway taken by trawling’ and ‘small quantities of pink snapper have been retained in the inner gulfs’) which leave the reader wondering about scale of these catches. These statements could be augmented by a brief summary of recent catches by the sectors or (less preferably) a reference to where these data are available (such as in the most recent State of the Fisheries Report).	AGREED. A brief summary of the history of the fishery by sector will be added to this section of the text, including a brief summary of the history of the commercial Shark Bay Pink Snapper Fishery and associated catches of pink snapper, and an equivalent section for goldband snapper and spangled emperor.
Where available (only for Shark Bay pink snapper?) a summary of the most recent status assigned to each of the three target species in the State of the Fisheries report would give an early indication of the stock status and help set the scene for the rest of the report.	AGREE. ACTION: Although this information is presented in the Executive Summary of the document, we will also repeat it in this section for clarity.
Also, any inability to assign a status to a key indicator species would be a point worth raising in the introduction under ‘Need’.	NOTE: We will refer to the DoFWA (2011) document in the text where appropriate. At the time of selecting indicator species this was the only information available. ACTION: Text towards the end of the ‘Need’ section (Section 1.2) will be revised.

Some explanations of terms could assist here as well. The term ‘mechanised handlines’, for example, sounds like an oxymoron. Does this just mean a powered reel? And also what are ‘wetline vessels’?

AGREED. ACTION: Footnotes will be added at first mention in the document to define terms.

2.4 General Methods

Sample collection

It is mentioned that no samples of oceanic pink snapper or goldband snapper were obtained from the recreational or charter catches as part of the study. This seems like a potentially serious omission but the need for such samples will depend on the relative catch by these sectors. Some comment in this regard would be useful.

AGREED: Approximately 80% of catches are from the commercial sector; typically the charter sector accounts for less than 2-5% of the total catches.

ACTION: A statement as to why catch sampling was focussed on commercial catches only will be added.

NOTE: The process used showed that the recreational sector take most of the spangled emperor catch. Therefore catch sampling focussed efforts on this sector for spangled emperor.

Some comment on the basis for sampling by fishery-dependent and fishery-independent methods would be useful. Fishery-independent samples are often preferable but more expensive. Were they only used when fishery-dependent information wasn’t available? Were they used to get different sorts of information?

NOTE: This was partially explained in the report in Section 4, page 23.

ACTION: Details will be added details to more adequately explain the basis of how decisions were made between fishery dependent and independent methods of sampling for each indicator species.

Have the collections been made with some specific target samples sizes in mind?

AGREED. ACTION: References to Craine et al. (2009) will be added. This document has been used as basis for determining target sample sizes for the commercial oceanic pink snapper fishery since 2004. In addition, the stratified (monthly) sampling that has been used for sampling the oceanic pink snapper stock since 2004 will be more fully detailed in the document.

Is it possible to develop and implement such a target or are most samples collected in an ad-hoc manner?	NOTE: Most samples were not collected in an 'ad hoc' manner. Sampling was focussed on the sector and times of year where most catches have been reported. For the recreational samples, sampling effort was apportioned to spatial and seasonal distribution of effort estimated from the most recent recreational survey data, as we describe in the report (last paragraph, p 23). NOTE: Recreational samples were also collected during interviews for the 2007/08 Recreational Fishing Survey (RFS), involving statistically designed random sampling stratified by month, location and mode of fishing (shore versus boat). Age samples from other sources were only pooled with samples from the statistically designed random sampling programme if it was demonstrated that there were statistically non-trivial variation among them, while guarding against the prospect of Type II error (□=0.25; Winer et al., 1992). Although this rationale was described on p 65, and test results referred to those presented in Marriott et al. (2010b), further details on the specifics of these tests for spangled emperor will be added for clarification. ACTION: Further text will be added to better describe how representative samples of pink snapper and goldband snapper were collected.

What measures are taken to ensure that, or examine whether, the fishery-dependent sampling is representative of the fishery?	ACTION: It was assumed that sampling based on the distribution of recreational effort estimated from the most-recent recreational survey would provide representative samples. This, in turn, assumes that landed recreational catches are directly proportional to recreational effort along Gascoyne Coast Bioregion. Statements will be added to the text as appropriate. NOTE: No additional data are available to assess representativeness for samples from the recreational sector, other than the data already presented in the report.
For an assessment based on an age-structured model, such as is used for pink snapper, a two-staged sampling approach is often used whereby the lengths of many fish are measured and the ages of only a subsample are determined. This approach may be preferred because length data are usually relatively cheap and easy to obtain whereas age data are expensive. Both data types may then be used as inputs to the assessment model or the age composition estimated outside the model by applying an age-length key to the length-frequency data. Such a two-stage approach is often a more efficient way to characterise the catch. For pink snapper it is possible that length and age are obtained for every fish sampled but it is not clear whether this is the case or whether a two-stage sampling framework would be more efficient.	AGREED. ACTION: A more-comprehensively explanation of how pink snapper commercial catch sampling has evolved over time will be added, in particular from 2004 onwards.

Sample processing

The description of the methods used for age determinations for all three indicator species are incomplete within the report. Detail on methods used to assign ages to increment counts should be included in the report.	AGREED. ACTION: A brief explanation of ageing protocols and birth date algorithms for the three indicator species will be added. NOTE: A separate document is in preparation describing ageing protocols for all indicator species that will be published in the future.

The PhD theses cited as containing the details for pink snapper (Wakefield 2006 and Jackson 2007) and are not readily accessible to most readers and do not allow others to replicate the methods used or readers to assess their appropriateness. Information subsequently provided by Dr Jackson (pers. com.) indicated that for pink snapper birth dates used in assigning ages to individual fish were either 1 June or 1 August depending on the particular stock. This choice of birth date, although ensuring that the transition of one age class to next coincides with the timing of spawning and increment formation, does not match with the assessment time step which groups other data on a calendar year basis. The potential implications of this mis-match are outlined below and discussed in more detail in Appendix 2.

NOTE: Finfish staff recently met (March 2011) to discuss the issue of aligning assessment year with birth date. It was agreed to investigate the effects of alignment using the oceanic pink snapper stock assessment as case study when next updated in 2011.

AGREED. ACTION: This will be further explored in the next scheduled assessment for pink snapper but not for this document. However, the risk of any significant change to the assessment is low. The next pink snapper assessments are due to be completed in 2011.

NOTE: A change in aligning assessment with birth years instead of fishery/ entitlement year may incur changes to all integrated models and age-based assessments of finfish in the State. The process will be complex and will require managers and stakeholders to be consulted. This will be explored in the future, noting that the effects of assigning years may have little effect on the overall outputs of any of the existing assessment models. However, it may reduce any “smearing” of age structure patterns among years; in particular on estimating recruitment deviations in an integrated model. There are likely to be minimal effects on outcomes of F-based assessments for these species (spangled emperor and goldband snapper).

ACTION: See comment above. The updated pink snapper assessments to be completed in 2011 will address this issue. We believe there is minimal value in redoing the current (2007) pink snapper assessments in this document as management actions have already been implemented based on the outcomes of the assessments and the results have been published. It is therefore a better investment of assessment resources in exploring these effects in future assessments.

For spangled emperor, the paper cited as containing the details about how increment counts were converted to ages (Marriott 2010c) contains the information on the selected birth-date (Oct 1) but refers to another paper (Marriott 2010b) for more details. This other paper, however, has only one sentence on the methods: "Fish that were sampled during the period of peak opaque increment deposition (1 October to 31 December) that had wide translucent otolith margins were assumed to have late forming opaque zones and the estimated age classes of these fish were the number of opaque increments counted plus one."	AGREE: Authors to add further details (e.g. see following Note for spangled emperor) on ageing protocols and age estimation to the report to clarify. NOTE: Marriott et al. (2010a) explains how age classes were determined from otolith increment counts and explains rationale underpinning the calculations. Age classes (i.e., the age of a fish, rounded down to whole years) were then converted into estimates of biological age (i.e., age class plus the fraction of a year lived since it deposited its last opaque increment) as detailed in Marriott et al. (2010b). Additional details will be added.
There is no mention of how samples with different margin types or caught outside this period were treated. For example, the substantial proportion of fish caught before the assigned birthday of October 1 already with an opaque margin were assigned an age should be assigned an age one less than the number of opaque increments.	AGREE: Details on corrections for margin types in age determination calculations will be added to the report.
The combination of the two papers, therefore, does not contain a complete description of the methods used.	ACTION: Aging algorithms will be added to the text to better clarify methods.
For goldband snapper the reference cited as containing details on how increment counts were converted to age estimates (Newman and Dunk 2003) contains no description on this process although at the assigned birth date (1 April) edge types are shown to include narrow opaque, wide opaque and translucent margins – which indicates that some algorithm is needed.	ACTION: Aging algorithms will be added to the text to better clarify methods. ACTION: An analysis of recreational 'year' versus commercial 'year' versus calendar 'year' will be undertaken to assess sensitivity of inputs on the outputs for goldband snapper and spangled emperor. NOTE: The new recreational surveys currently underway use a different 12-month period and are likely to therefore impose a different 'year' in future assessments.

Logbook data collection

More detail on the nature of the commercial logbook data collected would be useful. The reports are provided monthly but it is not clear if these monthly reports include data at the level of individual shots or days or just monthly totals. Some description of any quality control measures that are used to validate data would also be useful, as would mention of any studies that have attempted to compare logbook data with other measures of the catch (e.g. observer data or market data).

NOTE: This issue has been discussed with the Stock Assessment and Data Analysis Branch (SADA). Full descriptions of CAES data and a full description of the logbook are to be included in the text. Validation of commercial catch returns for pink snapper (oceanic stock) does occur via comparison with Catch Disposal Records (CDRs).

ACTION: Text will be added to state that the commercial fishery has CDRs and that these are used to validate logbook data for commercial catches of pink snapper.

ACTION: The long sentence on page 28 will be reviewed and clarified.

NOTE: Also reference to data in Section 6.

ACTION: Copies of current logbook forms will be added as appendices, including charter logbooks.

More information on how the data collected from the recreational sector, particularly the data provided by volunteers in the Research Angler Program, is used in assessments should be included. Providing the objectives of such data collection programs would be a start. Voluntarily provided data is prone to a series of biases (as discussed in an earlier review by Dr Steffe) that may limit its usefulness for stock assessment purposes.

NOTE: Recreational Angler Program (RAP) data were not used directly in assessments. These data were only used to estimate selectivity as RAP logbooks also record released fish (i.e. below legal size). These data are not included in per-recruit (PR) analyses.

ACTION: Statements explaining the RAP and RAP data will be added.

Analyses – rationale for spatial and temporal grouping of data

This section outlines the issues that arise from having data from the commercial and recreational sectors that have been collected over different time periods. It is not made clear in this section, however, how the issue was finally resolved.

NOTE: This couldn't be resolved as recreational data are currently only available for a single 12-month period. This could be undertaken for the commercial sector (i.e. fit to the 12-month period of recreational data) but this would discount more than 25 years of commercial data from commercial pink snapper (oceanic stock) fishery, noting that the recreational data for the one 12-month period may not adequately reflect the history of the recreational fishery. Therefore it was decided, since the peak period of effort for all sectors occurred over the winter months, to compare years with overlapping winter month periods (i.e. Winter 2007, as detailed in the report).

NOTE: F-based assessments provide coarse outcomes and re-analysis by using different temporal scales is likely to have little impact on the outcomes. The approach assumes no influence of annual recruitment variation on analysed age distributions and mortality estimates and so the method should theoretically be robust to how the sampling/analysis year is defined.

NOTE: The contemporary fisheries are almost completely single-sectorial and thus the assessments for each stock using the data from each individual sector will have little value when there are insufficient data to overcome variation attributable to sampling precision.

ACTION: Text from this section will be reviewed and modified as required.

There is mention that ‘ data for the commercial year 1 September 2006 to 31 August 2007 were compared to data for recreational and charter years commencing 1 April 2007 ending 31 March 2008’. It is not stated, however, whether the data are used in the assessment (for pink snapper) with this mis-match of years or, if so, why. If the commercial data are provided monthly it would seem relatively easy to regroup it onto the same yearly basis on which the recreational data are available. In the assessment there should at least be an assessment of the sensitivity of the results to different ways of grouping the input data.

AGREE. ACTION: Catch curve analyses for spangled emperor and goldband snapper stocks have been performed for all types of data year groupings, as relevant to this report (i.e., recreational: 1 April – 31 March; commercial: 1 September – 31 August; calendar: 1 January – 31 December). Results were qualitatively the same as those previously presented, and this finding will be added to the main text of the report, with detailed results added as an Appendix.

ACTION: Future assessments of pink snapper stocks (from 2011) will undertake sensitivity analyses to explore the influence of fitting the models to different types of data year groupings, noting it is likely to make little difference to the overall outputs.

NOTE: This has been explained in the ‘Rationale’ section.

ACTION: Text will be reviewed and modified as required.

It may make little difference to the final determination of stock status but it would be prudent to at least examine the potential effect.

NOTE: Comment addressed previously in regard to assessment ‘year’ versus biological ‘year’ (i.e. birth date).

There is an additional issue over the temporal grouping of these data that has not been examined. This concerns an additional mis-match between the years used for the commercial and recreational data, and those used in the assigning of fish ages, based on the birth dates. The details of this issue have been the subject of an email exchange and phone calls with Dr Jackson but a summary of the issues is contained in Appendix 2. The implications for the assessment depend in part on the allocation of samples among months and how much this varies from year to year. This could not be assessed from the information available.

NOTE: Comment addressed previously in regard to assessment ‘year’ versus biological ‘year’ (i.e. birth date).

Analyses – Rationale for adopting different assessment approaches for the different indicator species

This rationale is well explained and logical. It is sensible to tailor an assessment approach to the types of information available and its quality. What is not clear from this section, however, is whether the much simpler form of assessment used for spangled emperor and goldband snapper will also require a more precautionary approach in the determination of appropriate catch levels.

AGREED: This has been done.

NOTE: Explicitly stated and is implicitly incorporated in Tables 7.2 and 7.6.

ACTION: Text will be checked for clarity.

A more precautionary approach for these species would assist in keeping the overall risk levels similar across assessment types.

NOTE: Decision rules in Tables 7.2 and 7.6 from Wise et al. (2007) are already very precautionary. Currently, these fisheries are managed to the indicator species with the highest risk to stock sustainability.

NOTE: Precautionary approaches to be developed with managers during development of Harvest Strategies for this fishery and other fisheries from mid 2011 onwards.

2.5. Biological characteristics of key indicator species

Pink snapper

The distribution of pink snapper could be more clearly specified as around southern Australia as the current wording is ambiguous and the limits to the distribution in Queensland and WA could be interpreted (admittedly only by those with limited knowledge of the species) as the southern limits of a tropical distribution. The knowledge of the detailed structure of pink snapper stocks in this area is impressive and strongly supports the need to treat these adjacent areas as comprising separate stocks.

AGREE, ACTION: text will be modified to more accurately describe the distribution of pink snapper in Western Australia.

The number of samples obtained (Table 5.1.1) is generally good for the oceanic stock in recent years but there are troubling gaps in earlier years (pre 2003).	AGREED. ACTION: Text will be reviewed to and a better explanation included. This issue will also be addressed during the next oceanic pink snapper stock assessment in 2011.
The sample sizes for the Inner Gulfs, however, are quite variable and marginal in many years. Nothing can be done about this for past years but efforts should continue to be made to improve the number of fish sampled in the future.	AGREED. ACTION: These comments will be addressed in the text, noting the likely changes to future sampling. Additional comments to be added to clarify current sampling and any future sampling of inner gulf pink snapper.
The potential biases in the ageing data are well assessed. It is stated that “no significant trend in bias was evident ... from the most recent year” and the agreement between readers is generally very good, but Figure 5.1.1. suggests some bias in the ageing of the youngest two age classes in Denham Sound and Freycinet that should be examined further	AGREED. The reviewer has been contacted to determine the bias and has stated that the bias is unlikely to significantly influence the assessments results and outcomes. ACTION: This will be addressed in future assessments (2011). Text will be added to note this bias and its magnitude, noting subsequent advice from reviewer concerning likely implications for the presented assessment.
In fitting growth curves to the sexes separately I could see no reference to how samples from immature fish whose sex could not be determined were used (if there were any in the samples). Often these are allocated randomly to either male or female samples to keep the data sets independent.	AGREED. ACTION: Text will be added to detail how immature fish were used in fitting growth curves.
There are statistically significant differences in growth between the sexes estimated for two areas but not for the other two areas. The two areas with significant differences (oceanic and Denham sound) are also the two areas with the worst fits to the data (R2 <0.9) and for the oceanic stock the estimated L∞ value is much less than the observed Lmax. The actual fits of the curves to the data are not shown but it could be questioned whether there are biologically important differences in growth between the sexes.	AGREED. ACTION: Text will be modified to discuss statistical versus biological differences.

Consideration could be given to the use of a single sex model as any increased realism from implementing a sex-structured assessment could be more than offset by the increased number of parameters needing to be estimated from smaller datasets through having to split them for males and females.	NOTE: Stock assessment models for inner gulf pink snapper stocks are single sex. For the oceanic stock of pink snapper, the model was changed only to accommodate different von Bertalanffy parameters for males and females at the last iteration (2009) based on evidence of statistically significant differences in growth between sexes by the modeller (Peter Stephenson). The model was still fitted to catch at age data for both sexes combined. AGREED. ACTION: The benefits of sex-based differences in model parameters will be fully explored/ reviewed in the next assessments (2011).
Estimates of natural mortality are an important part of age-structured models. The methods used to provide initial estimates of mortality for pink snapper are rigorous but, as mentioned below, an alternative may be to use an assessment model that also estimates natural mortality as part of its parameter fitting process.	AGREED. ACTION: No sensitivity analyses for h (steepness) and M (natural mortality) were undertaken in early model iterations. However, these will be undertaken as part of next scheduled assessment for oceanic pink snapper stock (2011).
The patterns of recruitment for the Freycinet stock suggest that the 2000 cohort is the most dominant (Figure 5.1.5), but the actual age composition plot (Figure 5.1.3) indicates that 1997 cohort was much stronger. Commentary on the reason for this apparent discrepancy would be useful.	AGREED. ACTION: Further analysis of recruitment patterns with inner gulf pink snapper stocks is currently being undertaken. Text will be reviewed to more adequately describe the data.
The methods used and results for the various reproductive aspects are appropriate and well explained.	AGREED.
The discussion of the issue of discard mortality is important and the conclusion that it is likely to be a significant source of mortality is sound. Work to further quantify this mortality and to use the results in future assessments should be explored. It is unclear whether discards are currently factored into the assessment.	AGREED. ACTION: These comments will be addressed and text added as appropriate.

Spangled emperor

The variety of sources of samples raises questions about what constitutes a representative sample of the recreational fishery. The choice to use only samples from boat ramp surveys combined with donated samples as the 'representative sample' is essentially arbitrary but not necessarily wrong.	NOTE: SEE previous statements, noting that collection effort was based on the distribution of recreational effort and was assumed to be representative of recreational catches. ACTION: Reference to cite Marriot et al. (2010b) will be added
For the South Gascoyne the length-frequency distributions from the ramps, roving creel surveys and donated were not significantly different from each other (according to Marriott et al. 2010b although this analysis did not include samples from the charter sector or fishing tournaments) and presumably all samples could have been pooled in this region. The distributions from the charter sector or tournament samples do not seem to have been included in the pooled "representative" sample but in Table 5.2.1 these data are shown in bolder text which implies that they were '"used in/ considered for analyses"	AGREE. Clarification is required. ACTION: Details to be added to text for clarification (e.g., see following). DISAGREE. The treatment of data (i.e. to pool or not to pool for subsequent analysis) was appropriate. Data from only the recreational sector were considered due to sample size limitations and questions of representativeness of data collected from the other sectors. The number of pair-wise statistical comparisons were restricted given considerations of experiment-wise error rates and to include only representative recreational datasets. Tests to determine if pooling was valid were also adjusted for the prospect of Type II errors inappropriately inflating the statistical power of subsequent tests (i.e., the purpose of these initial tests). Similarly, only 'like' groups were pooled within each Region, given that the detection of a significant effect in one region was taken as evidence that this effect was non-trivial. The methodology follows that published in Marriott et al. (2010b).

There may be other defensible ways to use these additional data (e.g. through some catch-weighted combination of the samples) but at least the sensitivity to including or excluding the data could be explored. The choice of which data to include is difficult but generally all should be included unless there is some a priori reason to prefer one data source over another.	AGREED. ACTION: Text to be clarified by adding further details, such as those given above. NOTE: See above response concerning the treatment of data from different sectors and rationale for doing so.
The validation of the age estimates in the Marriott et al. (2010a) paper is relatively weak being entirely based on edge type analysis. This analysis shows that all edge types are found in all months across the sampled period with substantial variation between years in proportions of edge types in particular months. It is also not stated whether the reader determining the edge type knew the month of sampling at the time of reading (a potential source of bias with this validation method), but judging by the variability in the proportions it would appear not.	AGREED. ACTION: Text will be reviewed and modified in light of the recently published paper, Marriot et al. (2010b), noting that accurate age estimates have been validated for this species using this age estimation method in other published studies. These are also referred to in this report, including the bomb radiocarbon method by Kalish et al. (2002).
The analyses of growth curves are appropriate and the differences in growth between regions are substantial. The inclusion of statistics for males and females for the combined regions (Table 5.2.2) seems inappropriate given that it has already been found that the growth is different between the two regions.	AGREED. ACTION: Parameters identified by the reviewer will be removed from the table and text revised as appropriate.
The reproductive studies are well described and comprehensive. The batch fecundity estimates, however, show a surprising range (almost two orders of magnitude) and an increased sample size with a wider range of sizes and ages may provide a more precise estimate of this parameter.	AGREED. ACTION: Additional batch fecundity data have been collected since the draft report was submitted for review. Further collection and analyses will continue to support the next assessment.

The identification of post-release mortality as a potential issue is appropriate. Information on the size composition of the released component on the catch should be combined with estimates of post-release mortality to explore their potential influence on the assessment. Care should be taken to show consistency in the descriptors used for life history parameters. In Table 5.2.4 spangled emperor are described as having a long lifespan which matches the definitions in Table 7.3. When discussing ageing precision, however, both pink snapper and goldband snapper are described as being of moderate longevity but both also have maximum ages of at least 30 years. For goldband snapper F:M ratios are said to be "related to pre-determined reference levels developed by the DoFWA for long-lived (longevity exceeding 10 yr) species". The use of such terms should be consistently used or avoided and values quoted.	AGREED. NOTE: This information has come directly from Fisheries Research Report (FRR) 163. ACTION: Text on pages 13 and 156 will be changed to: " .. for species with intermediate (10-20 years) to long (> 20 years) life spans.." Text on pages 13 and 81 will be changed to: " … for species with intermediate (10-20 years) to long (> 20 years) life spans with otoliths of moderate reading complexity" This will ensure consistency throughout the report with the information summarised in Table 7.3.
Goldband snapper	
Table 5.3.2. reports 'precision' values but it would be helpful for some explanation in the text as to what an acceptable level of precision is, especially as another measure of precision, the average percent error, is used elsewhere for judging the suitability of data on catch at age. The precision of otolith readings was reported by Newman and Dunk (2003) to be "very high" but the average percentage error of 10.4% suggests a marginal level of precision. The average percent error in the report for the sample from South Gascoyne (1.45%) is a much more acceptable result.	AGREED. ACTION: These issues will be addressed and text modified as appropriate. Note that Newman and Dunk (2003) otoliths were not used in this report, as they were Kimberley specimens (i.e. from a different Bioregion and stock).
Validation ageing data is attempted using a relatively small sample size and sampling period and adds little to the more comprehensive results reported for an adjacent area in Newman and Dunk (2003), although this study itself suffers from the limitations of an edge type analysis.	NOTE: This has been (partly) discussed under the ageing section. ACTION: Text will be modified and cross-references to relevant sections in the report will be added for clarity and ease of reading.

The lack of modal progression in the two aged samples of goldband snapper (2005/06 and 2007/08) indicates that one or more of the following has occurred in at least some years: the ageing is inaccurate, the samples are unrepresentative, or the samples come from different stocks. Some discussion of the likelihood of these options would be useful. On the first possibility if the ages were assigned based on an April 1st birth date (as used in Newman and Dunk, 2003) and these age compositions have been grouped on a September to August fishing year, the observed differences could be attributable to differences in the months in which the majority of samples were collected in the two years (before April in 2005/06, after April in 2006/07). This may be an example of the year-class smearing discussed in Appendix 2.

AGREED. ACTION: Text to be added to discuss the potential issues/reasons for the lack of modal progression in the age structure data.

The potential for post-release mortality to become an issue if a MLL was introduced is acknowledged. Whether there is already any discarding in the commercial fishery for other reasons, however, is not clear.

ACTION: Text to be added to state that there is no evidence for the discarding of goldband snapper by the commercial sector.

2.6. Fishery characteristics and stock assessments

The grouping of species in catch and effort returns (for spangled emperor and goldband snapper) is a significant problem for any assessment that uses commercial catch and effort data, especially if there are no data on how the species composition has varied over time. Presumably the data used for the assessments are from samples for which the species identity is not in question but this issue should be clarified.

NOTE: Already stated as paragraph on North West snappers and jobfishes on page 96 of this Gascoyne report.

NOTE: Pooled species groups will be reanalysed to determine if trends in the data could reflect trends in species identification as much as any other reason.

ACTION: Statements about the outcomes of the analyses will be added as relevant.

The spatial aggregation of commercial catch data is understandable for the report but hopefully finer scale data are able to be used in the assessment. It could be important to know the extent to which the commercial fishery (both catch and effort) overlaps with the centres of activity for the recreational fishery. Are the areas fished just those that are closer to ports or does the distribution of effort reflect where the target species are found? Some statistics on the amount of overlap between the sectors could be reported presumably without breaching confidentiality requirements.

AGREED. ACTION: The maps of recreational catches and effort will be finalised once the recreational fishing survey data have been reanalysed. This work is currently being undertaken by the SADA Group. The data summarised in these maps are part of the supporting evidence for sampling being representative of the recreational fishery.

NOTE: The missing figures in the report will be added after reanalysis is completed by SADA.

Rotating all the maps of catch and effort would make them easier to read, especially in the final printed version.

NOTED: Maps can be rotated once they are finalised following reanalysis of recreational survey data (see above).

I found the structure of this chapter of the report in particular made it difficult to follow. It presents information on effort, catch, catch rates and assessments separately for each species. In my view it is easier to get the picture for a particular species if all the relevant data and the assessment results are considered together especially given that the types of input data and assessments differ so much. Readers (such as this reviewer) are more likely to want to cross-reference among data, results and conclusions for a particular species than among species. Therefore, in the review of this chapter I deal with the methods, data and assessment together for each species.

NOTE: This is consistent with FRR 163. Also, alternative structures were discussed before the construction/writing of the report occurred. This was discussed with managers and researchers and the present structure agreed upon. Also note that data have been summarised and bought together in tables throughout the report.

NOTE: Philosophically, DoF is moving from single species approaches to suites/multi-species approaches; the report structure is consistent with the DoF's philosophy.

Oceanic Pink snapper

The different methods of analysing the commercial catch rates for pink snapper show similar trends but the currently preferred 'Moran' method shows the least decline over the period shown. It would be prudent to examine the implications for the assessment of the other catch rate series being the more representative of the stock, as they may produce more pessimistic but still plausible outcomes.	AGREED. ACTION: More detail will be added to describe the history of development of the Moran-method to estimate catch rates and why this has been selected as the preferred approach. The usefulness of incorporating alternative approaches based on monthly catch and effort data will be explored in future assessments. When a sufficient time series of daily trip logbook data are available (i.e. at least 7-10 years of data), further investigation will be given priority.
The DFWA GLM method is said to include the catches of species other than pink snapper, presumably in an attempt to deal with issues of targeting. This approach carries the danger of confounding trends among the different species. Other ways to identify targeted effort should be explored.	AGREED. ACTION: Statements will be added around the inherent difficulties of identifying targeted catch rates for a species of interest from monthly catch returns in a multi-species fishery. Effort in the winter months is assumed to be directed towards pink snapper. The Moran-method uses data for key months for pink snapper (i.e. months when the highest catches are landed). NOTE: This is the reason why daily trip logbooks were implemented during 2009. Note the reasons for the use of the Moran-method are provided on p 130 of the report. Managers and key stakeholders agreed to use this approach to generate a CPUE trend.
The catch rate trends for the 'Moran method' shown in Figure 6.2.3 is labelled as extending to only one year more than Figure 6.2.1 (2006/07 vs. 2005/06) but seems to contain two extra data points and needs to be checked.	AGREED. ACTION: Figures will be reviewed and comments addressed as appropriate.

The integrated assessment model is reported to have been independently reviewed and modified as a result, which is a commendable initiative, but it would be even better to know if all the suggested improvements have been made.	NOTE: Integrated model based assessments of the oceanic pink snapper stock were externally reviewed in 2006 and some of the issues identified have been subsequently addressed. However, the review document was never published. ACTION: The implementation of the outcomes of the 2006 review will be summarised in the text.
Recruitment deviations were estimated from the first year of age composition data but it may be possible to extent this series back in time as, for a fish of this longevity, the age composition contains information on earlier recruitment events. The variance on the estimates can also be used to determine the earliest year for which such estimates are reliable.	AGREED. ACTION: This will be included in the next assessment runs in 2011. NOTE: This is applicable for all integrated models.
In the plots showing assessment results (e.g. Figure 6.3.1), it would be clearer if the projected biomass and F values are distinguished from those that have been estimated from the data. The basis for making the projections should also be explained (e.g. what catches were assumed to occur?)	AGREED. ACTION: These changes will be made.
To avoid ambiguity it would also be preferable if axes were labelled with the fishing years e.g. 2007/08 rather than 2008. Or the abbreviation should at least be made explicit in the figure captions.	AGREED. ACTION: These changes will be made.
The assessment for the oceanic stock is reasonably thorough but a range of sensitivity tests to alternative inputs or assumptions what would greatly add to an assessment of its robustness. The outputs show confidence intervals but these are presumably under the assumption that the model structure is correct and will underestimate the true level of uncertainty in the assessment. Values for key measures of interest, such as shown in Table 6.3.11, that would be estimated for different weightings to data series, alternative CPUE series, different levels of M, etc. help to assess how internally consistent the model is and whether there are any fundamental conflicts between different data sources.	AGREED. ACTION: This will be included in the next assessment runs in 2011. NOTE: This is applicable for all integrated models.

Inner gulfs pink snapper

Several of the comments above on the assessment for oceanic pink snapper are also pertinent to those for the inner gulfs.	NOTED
For the inner gulfs, the need to use the DEPM estimates as the index of abundance leads to a highly uncertain assessment given the wide confidence intervals attached to these estimates. At first I was puzzled as to why the estimated biomass trajectory passed through the error bounds of relatively few of these biomass estimates (only 14 of 22 estimates across the three stocks) but then I realised that the error bars were +/- 1 SD not 95% confidence intervals. The caption to Figure 6.3.5 should be explicit on what the error bars represent. The same comments about the value of sensitivity tests apply to this assessment. Given the imprecise estimates of biomass, the 95% confidence limits on the model and projections are also an underestimate of the true uncertainty in this assessment.	AGREED. ACTION: This section will be reviewed and comments addressed as appropriate. NOTE: Model projections also take into account age structure, not just daily egg production method (DEPM) outputs.
The assumptions behind the projections used to estimate the time to reach target levels should be more clearly spelt out. I presume that recruitment was estimated from the SR relationship but what catch levels were assumed?	AGREED. ACTION: Issues will be discussed with the modeller. Assumptions will be stated in the text. Note that the catch levels are the TACs (Total Allowable Catches). Text will be reviewed and more published information will be cited in the text.

Spangled emperor

The formal assessment of whether samples have sufficient precision to be useful in catch curve analyses is a good approach in principle but I am not familiar with the method used (from Craine et al. 2009) and do not feel qualified to comment on its robustness.	NOTED.

The different methods of estimating total mortality produce very different results with different conclusions regarding the ratio of current fishing mortality to natural mortality. The use of different methods and bootstrapping to calculate confidence intervals provide an indication of the variation in the potential range for the relevant parameters. Without a formal analysis of the potential biases in the different methods, however, it is difficult to know a priori which approach is more likely to provide the more robust estimate.	AGREED. ACTION: The potential trade-offs among methods will be added to the text, as discussed in Marriott et al. (2010b). The reason for adopting this approach was to capture a broader range of uncertainty (i.e. model selection uncertainty) by presenting results from a range of methods (as compared to FRR 163). Some models fitted different data sets better than others. Refer to Marriott et al. (2010b) where there is a discussion of the trade-offs.
CPUE is discounted as an index of abundance for spangled emperor because it 'has not been a consistent target species'. CPUE may still index abundance, however, if there has been a similar ratio of target to non-target fishing over time.	NOTE: The ratio of target to non-target fishing has changed over time. Therefore, nominal CPUE is not useful as an index of abundance. Nevertheless, the influence of factors suspected to influence CPUE (vessel, season) were explored in a supplementary GLM (generalised linear modelling) analysis (Appendix 2).
Also, a valid index might still be derived if another variable or combination of variables were themselves indicators of targeting (season, area or vessel). The inclusion of plots of catch rates and an Appendix with more detailed analysis suggests that some at least believe there is useful information in catch rates for spangled emperor. The comment on the suite of other factors that are known to potentially influence catch rates (other than the abundance) is, however, a well made cautionary note.	AGREED. Appendix 2 was added as a preliminary exploratory analysis of factors influencing the observed trends in CPUE.
The catch of spangled emperor by charter fishers is said to have decreased slightly from 2001/02 to 2007/08 but figure 6.1.18 shows no catch prior to 2002/03.	AGREED. ACTION: Consistency between figure and text will be checked.

It is stated that 'there was a large reduction in effort in the North Gascoyne from 91/92 onwards, which was concomitant with the commencement of the Pilbara Trap fishery'. The implication is that there was a shift in effort from one fishery to the other but Figures 6.1.4. and 6.1.5. show the decline in the wetline fishery effort starting earlier (from 84/85 in Zones 5 and 6 and from 87/88 in Zone 7) and the level of effort in the Pilbara Trap fishery is relatively small compared to the sudden drop after 90/91.	AGREED. ACTION: Consistency between figure and text will be checked.
It is also said that it is 'highly likely' that declines in catches and catch rates in the North Gascoyne have been caused by changes to management arrangements that prevented fishing in a number of areas. Some detail of the basis for this belief would be useful. What proportion of the previously fished area was closed? What proportion of the catch came out of these areas? What were the catch rates in these areas compared to areas that have remained open? How has effort in the open areas changed?	NOTE: Additional management actions have occurred. However, it is unclear as to the full range of factors that have affected CPUE. For supplementary analyses, 'vessel' had a significant influence on observed catch rates, thus it is possible that a restructuring of the fleet due to management changes may be driving the observed CPUE trend. AGREED. ACTION: Text will be received with a view to softening text around underlying cause.
There are different ways that the proposed effect could happen. It could simply be that the closed areas had higher catch rates and once these are excluded catches and catch rates will decline (regardless on any effort shifts). Closed areas could also lead to significant increases in effort in the remaining open areas causing localised depletion of stocks or gear competition, both of which might lower catch rates (but not necessarily total catch). The reasons are important because they do influence how indicators could change and hence how stock status is assessed.	AGREED. ACTION: See above statements.
It is hard to look at the relevant effort trends because the effort data are grouped differently (Zone 1 and Zone 3 individually and Zones 2 and 4 combined) to the catch and catch rate figures (Zones 1 to 4 combined) and effort for all the gears are shown in the one stacked plot. It would be worth plotting the effort data relevant to each catch rate index along with the catches.	AGREED. ACTION: Catch rates will be overlaid over effort data, as has been done for catch data.

The initial drop in catch rates from 75/76 to 80/81 for South Gascoyne is quite dramatic. A rapid increase in effort is proposed as a possible explanation but this only makes sense if it was the cause of a fish-down of a previously unexploited stock; this possibility should be mentioned.	AGREED. ACTION: This possibility will be mentioned in the text.
The analysis of spangled emperor CPUE presented in Appendix 2 seems to be a valuable advancement on the catch rate trends presented in the body of the report. It is unclear why it has been relegated to an Appendix. It suggests that the decline in the raw catch rates in North Gascoyne underestimates the true decline in spangled emperor abundance. For the South Gascoyne, the trends look to be more similar. Comparisons are difficult, however, without the different time series being graphed together.	AGREED. ACTION: See above statements. NOTE: The information in Appendix 2 was based on entire blocks only and doesn’t spatially with the assessment zones (spatially). Therefore, this analysis does not match with the spatial divisions of the analyses in the rest of the report.
Reasons for the differences in the size compositions between Charter vessels and Recreational fishing should be explored further once the revised effort information is available. More information on the differences in the areas fished and gear used would help back up the statement that these are possible reasons for the observed difference.	AGREED. ACTION: This will be reviewed once finalised recreational data are available. Differences in areas fished between sectors will be made clear when recreational effort maps are provided. NOTE: Both sectors use similar gears.
The use of catch curves and yield per-recruit analyses are well accepted ways of assessing the impact of fishing on target populations. They are applied appropriately here (and for goldband snapper) with an appreciation of the assumptions behind these methods.	AGREE.
The conclusions drawn are justified by the assessments conducted with caveats given.	AGREE.

Goldband snapper

The analysis of the data on catch and CPUE is appropriate and the conclusions drawn reasonable.	AGREE.

The results of the different methods of catch curve analyses are more consistent for this species than for spangled emperor but the same questions about which is the preferred method still apply. The conclusion that this fishing has had no detectable effects on the population age structure is nevertheless reasonable given the analyses and reflects the relatively large numbers of older fish still present in the population.

AGREED. ACTION: See above comments for spangled emperor catch curve analyses.

The yield per recruit analyses are undertaken appropriately and the exploration of the effect of changing the age at selectivity is worthwhile given available information.

AGREE.

Discussion

This section is more of a summary of the results chapter than a discussion of the findings – which is in the next chapter – and could probably be more accurately titled as such.

AGREED. ACTION: The title of this section will be changed to, "Summary of key findings".

7 General Discussion and Implications

Table 7.1 outlines the suggested management actions (in general terms) under different combinations of status for fishing mortality and biomass indicators for species where estimates of both these parameters are available. It would be helpful to include in this table (or in the text of this section) the specific values for the target, threshold and limit reference points for both biomass and fishing mortality. These are provided elsewhere in the report but would aid in understanding the decision rules to have them listed here also.

AGREED. ACTION: Decision rules will be added to this section of the text

Tables 7.2 and 7.3 are both described as ‘weight of evidence assessments’ but Table 7.2 covers the situation where estimates of biomass and fishing mortality are available. In such a situation a weight of evidence approach should not be necessary, unless it has been decided that other indicators should be used even when assessment models provide estimates of these parameters. If this is the case then any additional indicators selected should not include those where the data used to derive them may have already contributed to the original assessment (e.g. growth, natural mortality, or as shown in Wise et al. 2007, catch, effort, age/length distributions). To do so would give double-weighting to such data.

AGREED. ACTION: Table 7.2 doesn’t include situations where both F and B are available; it only includes situation where you have access to one or the other.

NOTE: The term “Weight of evidence assessment” has been removed from Table captions, and that the decision rules relate to F-based assessments for spangled emperor and goldband snapper has been added for clarification. As there were no estimates of biomass (B) available for spangled emperor or goldband snapper stocks studied in this report, details on the biomass (B) decision rules have been removed.

Despite its title, Table 7.2 seems to represent bases for decision rules that are not weight of evidence approaches. Each of the levels of information presented (biomass, fishing mortality and catch rates/catches) can be, and are elsewhere, used in decision rules on their own. For example, one of the methods of estimating fishing mortality for spangled emperor and goldband snapper is very similar to that currently used to recommend catch levels for ‘Tier 3’ species in the South East Scalefish and Shark Fishery (Wayte and Klaer 2010). Similarly, catch rates are used in a decision rule for ‘Tier 4’ species (although not without many points of contention, from both scientists and industry, about the validity of the approach). There have been a range of benefits from the adoption of a set of decision rules for all levels of available data in this fishery (Smith et al. 2008).

AGREED. ACTION: See above comments.

Assessments based on estimates of biomass and fishing mortality provide measures of different aspects stock status. Fishing mortality estimates can only say whether the current rate of harvest is likely to constitute overfishing whereas biomass estimates can help say whether a stock has been overfished or not. Both measures are important and could be more clearly linked to the indicators and selected reference points. The term overfishing is currently only used in reference to the results of the yield per recruit analyses.	AGREED. ACTION: Use of the term 'overfishing' in the spangled emperor assessment will be reviewed. Also, see above.
For spangled emperor and goldband snapper, for which estimates of fishing mortality have been derived, it seems that the estimates for these particular species are not considered to be robust, and are apparently regarded as unsuitable for use in the decision rules for fishing mortality as outlined in Table 7.2. If this is the case the reasoning for this decision was not readily apparent.	NOTE: Fishing mortality (F) error bars in the spangled emperor assessment are very wide. To include error in F you need to sum variances around Z (total mortality) and M (natural mortality). For goldband snapper, there is currently no estimate of uncertainty around M. Therefore this was not undertaken. NOTE: The DoF are currently developing a new approach for estimating uncertainty around M to be included in future assessments (in development). For spangled emperor, error bounds around M are available but are wide and include biologically implausible values. Therefore there is currently no plausible basis for estimating error/uncertainty in F for spangled emperor. ACTION: Statements will be added to the text in regard to the above notes, as stated in Marriott et al. (2010b). Reference to the Marriott et al. (2010b) peer-reviewed and published paper will be inserted in the text where appropriate.

I found the caption to Table 7.3 to be confusing and think it could do with some re-wording. The column headings are also confusing because they do not describe the column contents but represent the level of management intervention proposed under the situations described. The table represents criteria for scoring the relative vulnerability of a species to fishing for six different factors; the headings represent the step taken after the risk has been evaluated.

AGREED. ACTION: Text of this caption will be reviewed and clarified.

Care should also be taken to define the criteria used in the table of current status and vulnerabilities to ensure that they are not correlated. If they are correlated there is the potential for double-counting and a possibly unintended over emphasis on some characteristics. Maximum age is related to natural mortality and growth which are probably all related to vulnerability to fishing and rates of recovery after depletion.

NOTE: These are generalities, often exceptions. Also, see next response.

Table 7.3 focuses on the inherent characteristics of individual species but in assessing the risks that a specific fishery poses to a stock there is also benefit in considering (separately) some attributes of the fishery e.g., does it operate over the entire range of the species, does it target aggregations, and does it catch immature fish? These are especially important aspects to include in an assessment because they are the only factors that are potentially amenable to change through management intervention. Including fishery specific factors in the risk assessment is desirable because the source of any risks should be identified as part of a risk assessment process. Once included such factors also allows for a formal and transparent re-scoring of risk under proposed or actual changes to the fishery (in gear used, areas fished, level of effort etc.). A two axis approach (species characteristics and fishery attributes) is described in the approach used for risk assessments in NSW (Astles et al. 2009 and papers therein) and is also being employed for assessing risks posed by fisheries in Queensland. Fishery characteristics are included in one of the three broad groups of categories used to select indicator species, and are described in detail in the report reviewed here, but they do not seem to contribute formally to the risk assessment.

AGREED. ACTION: The Research Division is currently in the process of further developing and refining the approach as represented in Tables 7.3 and 7.6, following these suggestions. As part of this process, we are also looking to approaches that have been developed elsewhere (e.g. Productivity Susceptibility Analysis (PSA)). This is an important step for all future assessments, as it is for the Weight of Evidence approach, as developed by Wise et al. (2007).

There is potential benefit in adding a further step after the scoring of the risk against each of the vulnerability attributes for spangled emperor and goldband snapper to provide an overall risk score. Tables 7.4 and 7.5 score each stock and species against the criteria but there is no attempt to combine these scores. This may be a deliberate decision but the additional step would be useful if these scores are to lead transparently to the proposed management responses. For example, pre-specifying how many high scores are needed before a high reduction in fishing effort is deemed to be required, and what spreads of scores leads to a medium reduction in fishing effort, could assist in avoiding extensive post-assessment debates and lobbying when management responses are proposed.

AGREED. ACTION: Table 7.6 will be modified and the caption changed to include, "modified from Wise et. al. (2007)."

ACTION: The above changes will be discussed with other Research Scientists for wider applicability to all assessments (see above).

There seems to be a disconnection in the risk assessment method as Tables 7.4 and 7.5 do not use the same factors as those listed in tables 7.2 and 7.3. For example age/length distributions and effort/catch have been added. Catch rates are listed in Table 7.2 but are not mentioned in the risk tables.

AGREED. ACTION: Tables and text will be reviewed and clarified.

7.0 Comment on the response to the review of "Biology and stock status of demersal scalefish indicator species in the Gascoyne Coast Bioregion" Marriott *et al.* 2010.

by Mr. A. K. Morison, Morison Aquatic Sciences for the Department of Fisheries, Western Australia

The responses to the issues raised in my review of this report by the Department of Fisheries are appropriate and acceptable. I am quite comfortable that the proposed responses will effectively deal with all the concerns that I had raised.

I would like to reiterate my view that the Report is a comprehensive treatment of its topic, that the assessments are thorough and that the advice based on these assessments is sound and appropriate for use in the IFM process.

Furthermore, the combination of inviting initiating the review and then publishing the review and response is a great example of transparency in the assessment process that in my view meets world best practice.

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14 July 2011

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