# ANNEX 11

*25th Meeting of the*
*International Scientific Committee for Tuna*
*and Tuna-Like Species in the North Pacific Ocean*
*Busan, Republic of Korea*
*17-20 June 2025*

# REPORTING WCPFC SC STATUS AND MANAGEMENT ADVICE FINDINGS AND RECOMMENDATIONS FROM WCPFC PROJECT 113B

**June 2025**

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# Reporting WCPFC SC Status and Management Advice

## Findings and recommendations from WCPFC Project 113b

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## Cover Notes

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## EXECUTIVE SUMMARY

The Western and Central Pacific Fisheries Commission (WCPFC) is responsible for the conservation and management of tuna and other highly migratory fish stocks in the Western and Central Pacific Ocean. A critical component of this responsibility is the accurate and consistent reporting of stock status and management advice based on scientific assessments. The present study, conducted as part of Project 113b, aimed to develop recommendations for a more standardized approach to reporting stock status and management advice from stock assessments, as recommended by the review conducted as part of Project 113 and presented to SC19.

The research involved a survey of 17 participants (15 managers and 2 scientists) to gather insights on the effectiveness of current reporting methods and preferences for future improvements. Additionally, the study examined best practices from other jurisdictions and scientific literature, particularly drawing inspiration from the Intergovernmental Panel on Climate Change (IPCC) guidelines for reporting uncertainty.

The importance of this work lies in its potential to enhance the WCPFC's ability to implement precautionary approaches to fisheries management, as mandated by the WCPFC convention. By improving the consistency and clarity of stock status reports and management advice, the Commission can make more informed decisions and better track changes in stock status over time.

Key findings from the survey and analysis include:

- Current reporting of stock status and management advice lacks consistency across different fish stocks, making comparisons and trend analysis challenging.
- While the detail and clarity of current reports are generally considered sufficient, the reporting of uncertainty is not consistently adequate across all assessments.
- Uncertainty is recognized as an important aspect of stock assessments, both for stocks with and without explicit management strategies.
- The communication of uncertainty and its consideration in management decisions could be improved to better support the application of the precautionary principle.
- There is a need for a more structured and standardized approach to reporting, including consistent terminology and formatting across different stock assessments.

Based on these findings and a review of best practices, the study proposes several key recommendations to improve the reporting of stock status and management advice:

Key recommendations:

1. Rename report sections for clarity: "Stock Assessment and Trends" and "Stock Status and Management Advice".
2. Implement consistent section content structures for both renamed sections, including specific elements like assessment structure, uncertainties, catch estimates, and management quantities.

3. Use consistent language for describing uncertainty:
    - Apply a 3-level confidence scale (high, medium, low) in the ”Stock Assessment and Trends” section, where confidence relates to the assessment’s ability to capture key uncertainties.
    - Use IPCC likelihood categories with corresponding probability statements in the ”Stock Status and Management Advice” section.
4. Tabulate main sources of uncertainty in the assessment, including rationale, impact, and confidence level.
5. Provide a standardized stock status table in the ”Stock Status and Management Advice” section, including probability statements and likelihood categories for key status indicators.

By implementing these recommendations, the WCPFC can enhance the transparency, consistency, and comparability of stock assessments across different tuna and associated stocks, and over time. This improved reporting framework will facilitate more informed decision-making by the Commission and support the sustainable management of tuna and associated stocks in the Western and Central Pacific Ocean.

# 1. INTRODUCTION

Reporting of stock status, management advice, and associated uncertainty, is a key component of the fisheries management process, enabling a precautionary approach to fisheries management by the Western and Central Pacific Fisheries Commission (WCPFC) as prescribed by the WCPFC convention (Article 6). A review of stock assessments and reporting by the Scientific Committee (SC) conducted under Project 113, and presented to SC19, found that this reporting lacks consistency across SC reports to the commission, making it difficult to compare between assessments and to track changes in stock status over time.

Internationally, there is no accepted reporting standard for reporting of stock status, management advice, and associated uncertainty. Many countries and RFMOs prescribe items to include in such reporting (e.g., NOAA Stock Assessment and Fishery Evaluation (SAFE) report), and others have implemented standardized reporting for stock assessments (e.g., New Zealand plenary reports; CCAMLR reporting is standardized and accessible through a reporting app). However, there is no standard for how this information should be summarized and presented to managers. Especially, the treatment of stock assessment uncertainty has been inconsistent in this regard (Cadrin et al. 2015). At worst, a lack of consistency can lead to misinterpretation of the information presented, and can make it difficult for the commission to make informed decisions on the management of tuna and associated stocks in the WCPO.

A practical approach to enhance and unify the reporting of assessment advice, and uncertainty and risk in fisheries management, is to create a standardized template. This template can accompany stock status reports and management recommendations, explicitly outlining various uncertainties. In 2015, an international panel of experts on "Addressing Uncertainty in Fisheries Science and Management," organized by the National Aquarium in the United States, proposed such a template as an innovative solution (Cadrin et al. 2015). They suggested developing a comprehensive table or checklist that would identify major sources of uncertainty specific to each fishery. This tool would detail how these uncertainties are addressed, and their potential impacts. Such an approach would not only foster better understanding among all stakeholders, but also highlight existing measures for managing uncertainty, and pinpoint areas requiring further attention. In addition, this could promote greater visibility of the improvements to the assessment process over time.

This project (Project 113b) developed such a framework for consistent reporting, and applied this framework to the most recent stock assessment for an example stock in the WCPO. The project also developed a set of guidelines for the WCPFC SC to ensure that future stock assessments are reported in a consistent manner. This will improve the transparency and robustness of the stock assessment process, and facilitate informed decisions on the management of tuna stocks in the WCPO.

# 2. SURVEY

A survey was conducted to understand how managers view the current reports prepared by SC to the commission, and how these might be improved. The survey was designed on Google Forms, which allows for straightforward extraction of the responses as data, and further analysis of the results. Some respondents and government departments could not access the survey due to internal restrictions. A MS-word version of the survey was therefore prepared and disseminated. Results from the MS-Word responses were added into the Google Forms to enable a single source of data to be used for qualitative analysis.

The survey was answered by 17 participants, with 15/17 identifying as managers, and 2/17 as scientists. While some answered on behalf of a particular delegation, other delegations provided multiple individual answers. Survey answers were not weighted, given the low number of over-all respondents. Also, we did not categorise answers according to the type of respondent (manager or scientist), or otherwise, as answers were used as qualitative guidance only, and were not evaluated quantitatively to determine recommendations.

## 2.1 Current reporting

Although respondents generally agreed that the current reporting of stock status and management advice is sufficiently detailed and clear, there was a mixed response with regards to reporting of uncertainty being sufficient, where only ≈2/3 of respondents considered current reporting of uncertainties sufficient for understanding risk: a majority of respondents thought that the current reporting is not sufficient or consistent across stocks (Figure 1).

## 2.2 The role of uncertainty, and translating uncertainty into management advice and decisions:

Respondents generally agreed that uncertainty is an important aspect of reporting stock assessments, both for stocks with management strategies and those without explicit management strategies (Figure 2). However, there was less agreement on whether uncertainty is sufficiently communicated to enable the application of the precautionary principle under the convention text, where only 29% of respondents considered that stock assessment advice is sufficiently informative for this purpose (Figure 3). 53% of respondents considered that that the role of uncertainty in stock assessments is sufficiently considered by the WCPFC SC when formulating management advice, and only 44% considered that uncertainty is sufficiently considered in management decisions. Nevertheless, 62% of respondents considered that uncertainty influences management decisions at the WCPFC.

## 2.3 Developing a template to report stock status and management advice

Respondents were asked to consider a template for reporting stock status and management advice, and to provide feedback on the elements of the template. The template elements were based on aspects of the WCPFC SC's stock assessment advice, as well as recommendations from Project 113. All aspects suggested were found

to be important (Useful or Must-have) (Figure 4). We considered that support for the proposed elements was sufficient to consider these in reporting stock status and management advice, and that a sufficiently clear structure should make it make it easier for managers to find the information they consider most useful in a consistent manner.

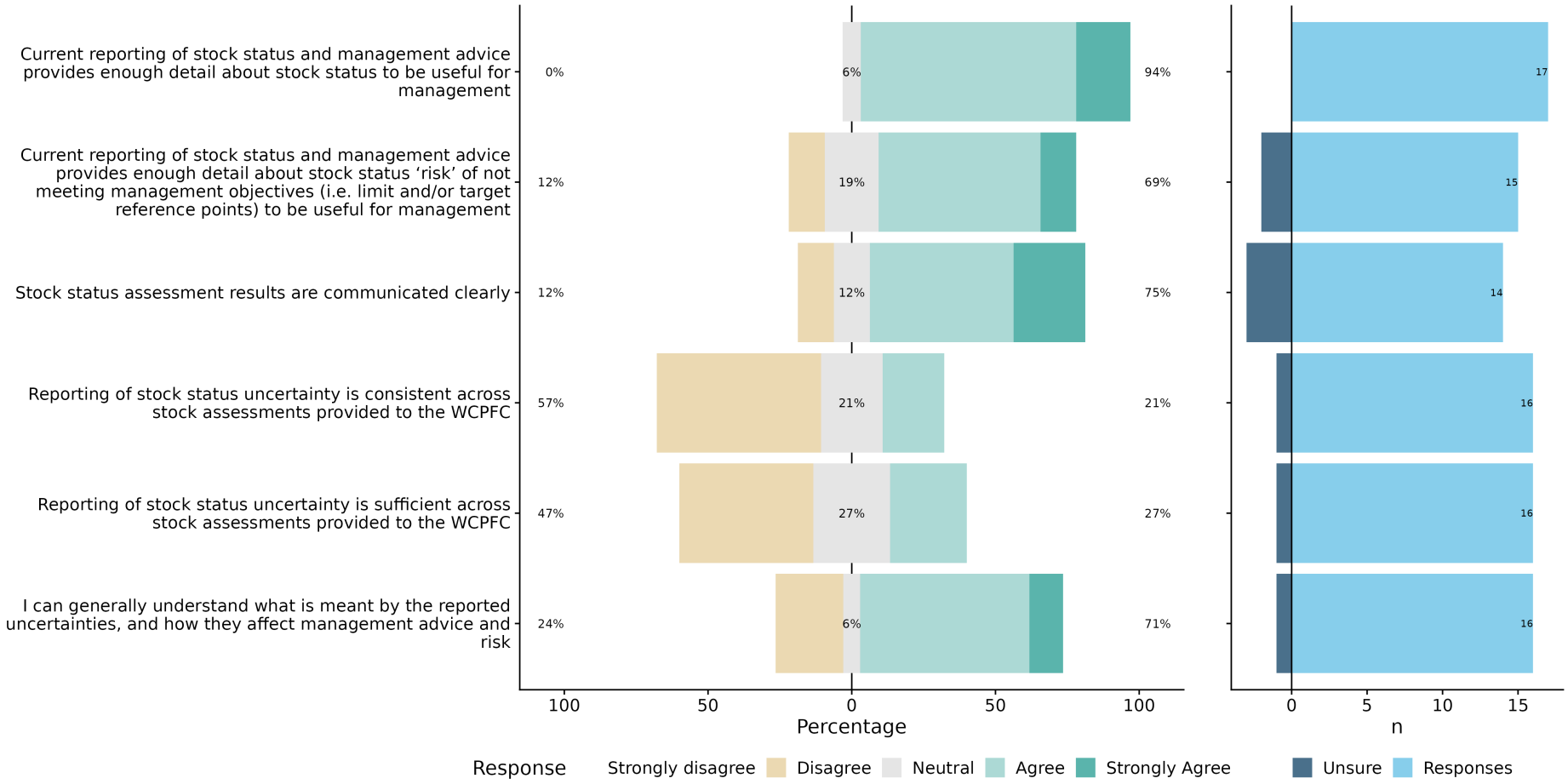


**Figure 1:** Survey answers to questions regarding current reporting of stock status and management advice on the basis of stock assessments considered by the WCPFC SC.

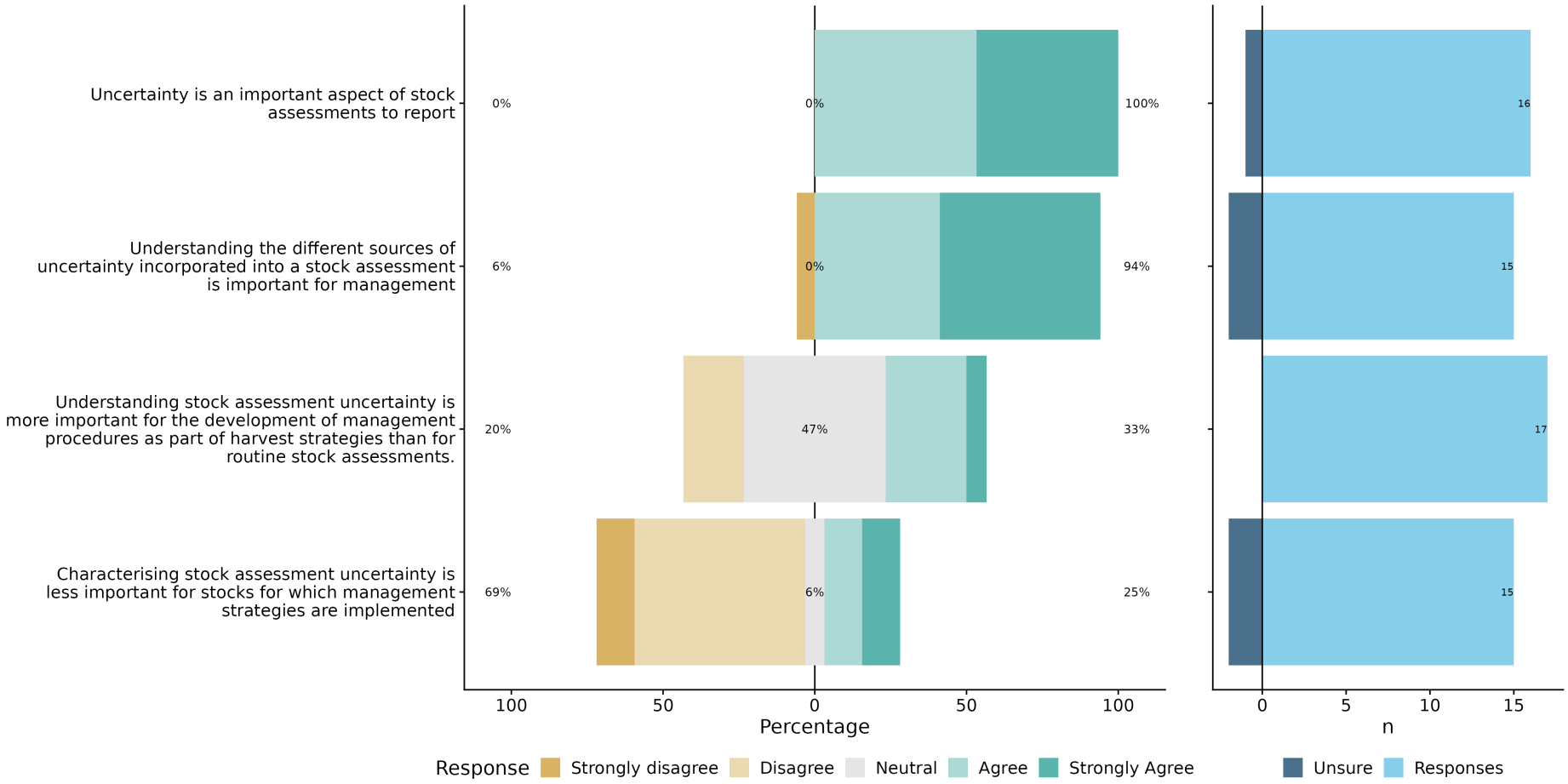


**Figure 2:** Survey answers to questions regarding the role of uncertainty in stock assessments considered by the WCPFC SC.

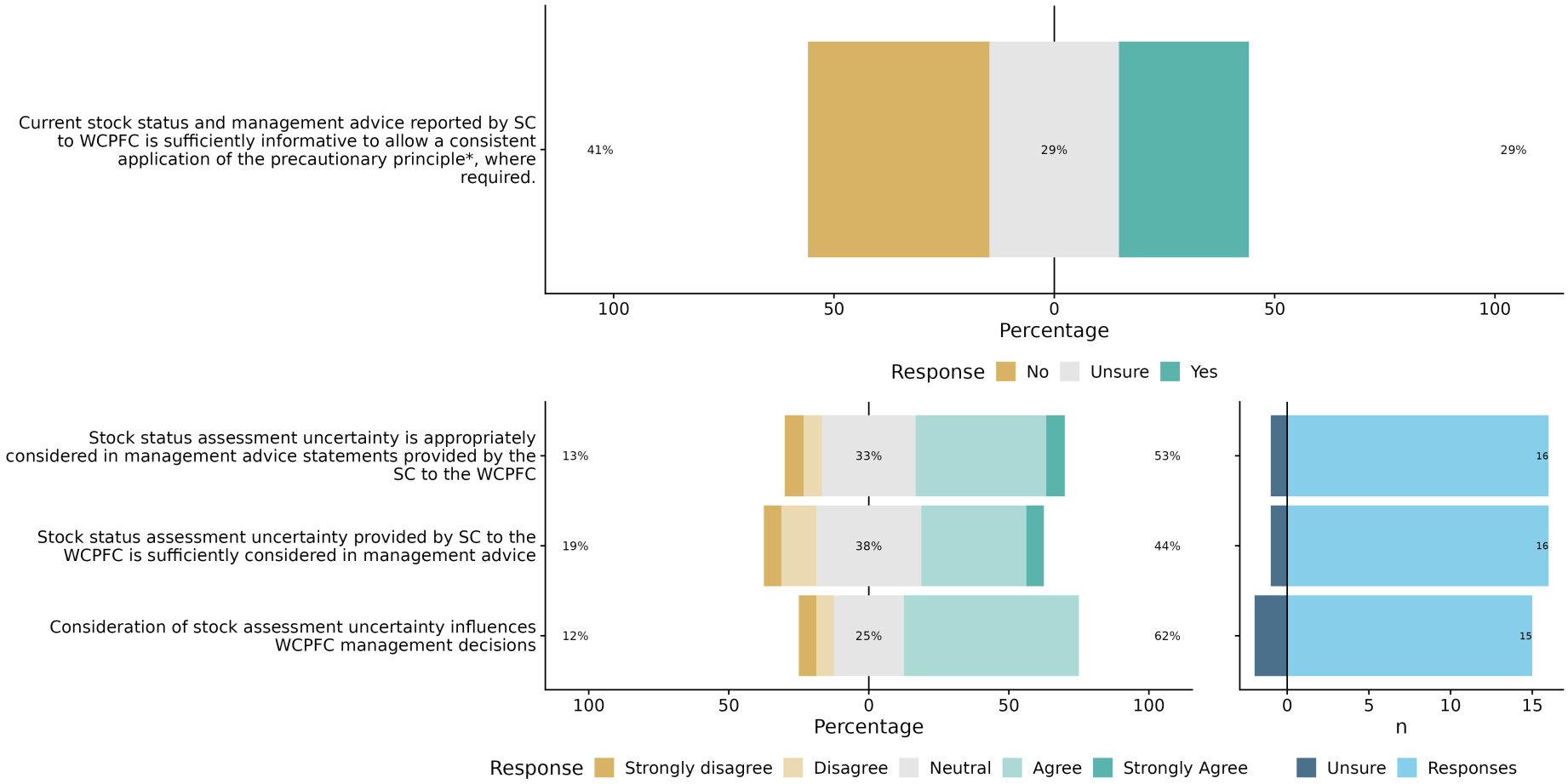


**Figure 3:** Survey answers to questions regarding the translation of stock status to management advice and decisions from stock assessments considered by the WCPFC SC.

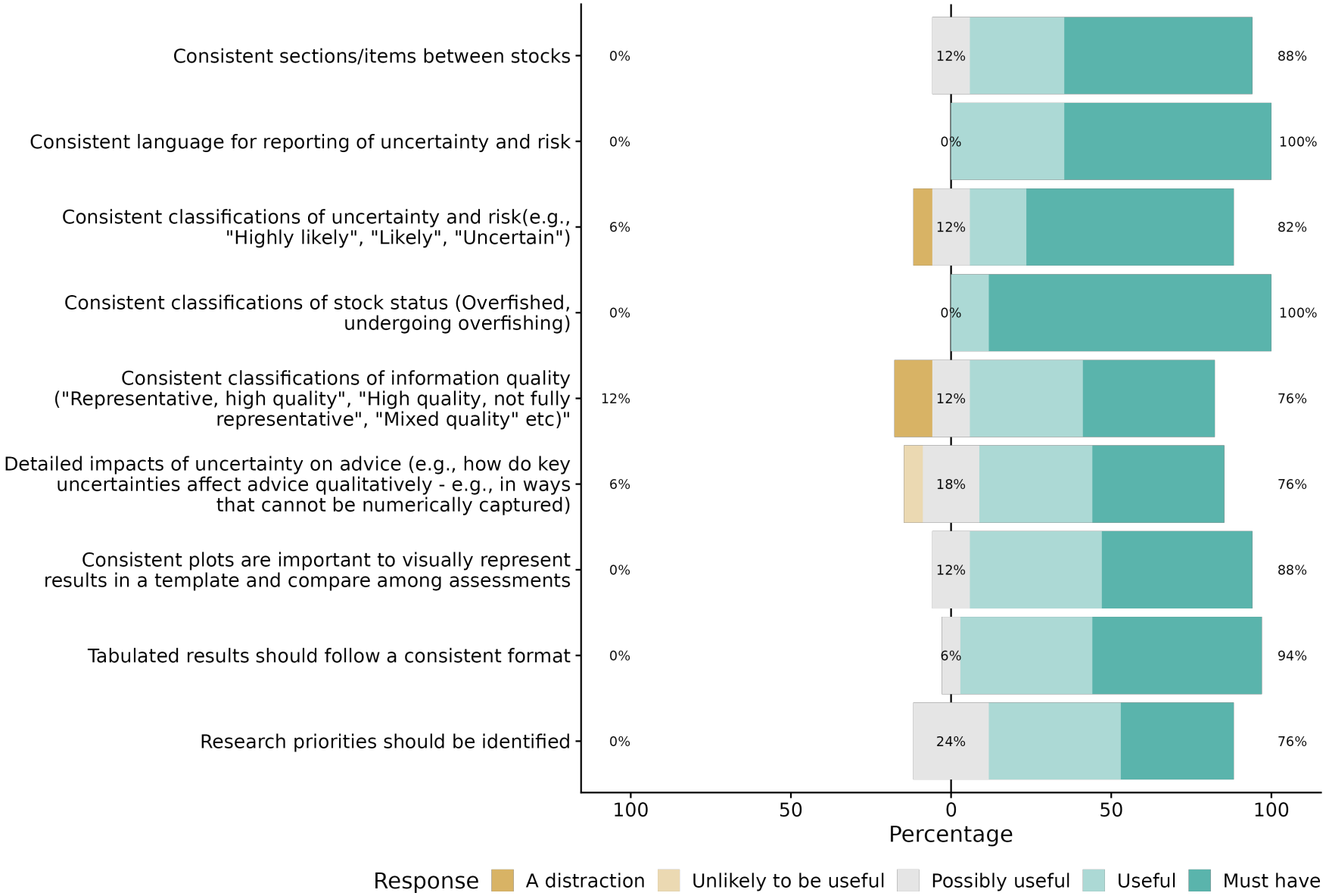


**Figure 4:** Survey answers to questions regarding elements for templated reporting of stock assessment advice developed by the WCPFC SC.

## 3. IMPROVING CONSISTENCY IN REPORTING

The survey results clearly supported the need to improve consistency in reporting. Most respondents felt that the current level of information was adequate, or nearly so. However, respondents also felt that the reporting of uncertainty was less adequate and did not fully support the mandate of the commission to apply the precautionary principle in fisheries management.

To develop more consistent reporting, the current reporting of SC stock status and management advice should be considered, as well as best practice in other jurisdictions, along with scientific literature regarding the reporting of stock status, management advice, and associated uncertainty. Indeed, while the latter is not well developed in the current reporting, it is well researched in the context of climate impact assessments and projections.

The current reporting of stock status and management advice is based on descriptions of key stock assessment results, including estimates of biomass trajectories, fishing mortality, and recruitment. These are typically presented in the form of tables and figures, and are accompanied by a narrative that describes the key results and the implications for management. The current reporting of uncertainty is less consistent, and is typically limited to a qualitative discussion of the uncertainty in the assessment results. For assessments provided by the Pacific Community Ocean Fisheries Programme, the uncertainty is typically described in terms of estimates and quantiles for biomass and fishing mortality relative to reference points, as well as the proportion of models in an uncertainty grid that breach limit reference points..

The most commonly used uncertainty characterisation is that developed by the IPCC in the context of reporting on climate change vulnerability, impacts and adaptation, which are widely used in the scientific literature (Swart et al. 2009, Kause et al. 2022). Crucially, these statements evaluate the evidence (akin to stock assessments) and produce predictions of outcomes and potential adaptation options (akin to projections and management advice), providing a comparable context to fisheries assessment and management process under uncertainty. The IPCC guidelines include a set of definitions and guidelines for reporting on the likelihood of different outcomes, and the confidence in the underlying evidence. These guidelines support transparency, consistency, and comparability, and are designed to support the use of scientific information in decision-making. Specifically, they "...communicate the degree of certainty in key findings:

1. Confidence in the validity of a finding, based on the type, amount, quality, and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and the degree of agreement. Confidence is expressed qualitatively.
2. Quantified measures of uncertainty in a finding expressed probabilistically (based on statistical analysis of observations or model results, or expert judgment)." (Mastrandrea et al. 2010)

The first point expresses the confidence in data, models and other aspects (or assessment) that lead to the findings, while the second point expresses the uncertainty in the findings (or stock status) themselves. This is a useful distinction, as it allows for a clear separation of the confidence in the underlying evidence from the uncertainty in the findings. This

is particularly important in the context of stock assessment, where there may be varying degrees of confidence in different aspects of the assessment process - the data, analyses and models - which all contribute differently to the uncertainty in the assessed stock status.

Confidence measures, according to the IPCC, are expressed in terms of evidence (limited vs robust evidence) and agreement (low vs high agreement) between studies. To assign the highest confidence, there must be robust evidence and high agreement between multiple studies. It may be argued that for many aspects in stock assessments there are often few studies to compare, and that the evidence is often limited. As a result, it may be useful to simplify the concept into a simple scale of confidence, which is based on the combined evidence and agreement (i.e., the diagonal of the two-dimensional IPCC scale).

The likelihood scale expresses the probability of an outcome, such as stock biomass being above the reference point, and is based on the probability of the outcome given the evidence and associated confidence. The likelihood scale is expressed in terms of qualitative terms (e.g., virtually certain, very likely, likely, unlikely, very unlikely, exceptionally unlikely), and is designed to be consistent with the probability scale while being more easily understood by non-experts. However, recent research suggests that these terms are not consistently interpreted, depending on cultural and personal context as well as the context of the statements themselves (Kause et al. 2022). As a result, it may be useful to supplement the qualitative terms with a corresponding quantitative probability scale which is more easily understood and more consistent across contexts.

New Zealand's fisheries plenary reports have adopted the IPCC likelihood scale for the reporting of stock status as a way to standardise fisheries reporting, albeit with modified limits for intermediate categories. The IPCC scale, as a researched and widely used scale, was also suggested by survey respondents in this study, as it is a good choice for consistency and comparability of stock assessment outcomes and stock status statements. In addition to consistent terminology, it is important to consider the content of reports to ensure that these are consistent and informative. The IPCC guidelines suggest that reports should include a summary of key findings, a description of the evidence and the confidence in the findings, and a description of the uncertainty in the findings. These elements are considered in the recommendations below.

## 4. RECOMMENDATIONS FOR REPORTING OF STOCK STATUS AND MANAGEMENT ADVICE

At a high level, it may be preferable to maintain the current structure of SC stock status and management advice, and to improve the transparency and consistency of the advice provided by instead changing the way the advice is presented. Specifically, the following changes are recommended:

1. **Rename sections of the Stock Status and Management Advice report to better reflect the content:** Currently, reports are split into "Stock Status and trends" and "Management Advice" sections. However, the content of each is not always consistent with the title, and the two sections are not always clearly distinguished. The Stock Status section should be renamed to "Stock Assessment and Trends",

and the Management Advice section should be renamed to "Stock Status and Management Advice". This will help to clarify the purpose of each section and make it easier for users to find the information they are looking for. The "Stock Assessment and Trends" section outlines the evidence and modelling results used to assess the stock, while the "Stock Status and Management Advice" section measures the performance of the stock against management objectives (i.e., stock status; expressed as biomass relative to target and limit reference points) and the resulting advice provided to managers based on status and trends.

2. **Consistent section content:** The "Stock Assessment and Trends" section should be structured consistently across all stocks, with a clear description of the methods used to assess the stock, the data used, the model used, and the results of the assessment. These results should be provided in a consistent manner by following a list of core paragraphs about data inputs, uncertainties, indicator trends and assessment outcomes. The recommended structure for the section is as follows:

   *Stock Assessment and Trends*

   (a) Describe assessment structure and rationale (Figure 1, Table 1)
   (b) Describe main uncertainties considered (Table 2)
   (c) Describe annual catch estimates and trends (Figure 2)
   (d) Describe CPUE trends and other indicators of biomass trends (Figure 3)
   (e) Describe trends in diagnostic model, including recruitment, spawning potential and fishing mortality (Figure 4-6)
   (f) Describe the depletion of spawning stock biomass and associated uncertainty (Figure 7)

   - Table 1. Assessment structure, including key fisheries and catch proportions. No defined format to accommodate alternative assessment methods.
   - Table 2. Summary of main sources of uncertainty in the assessment, with a degree of confidence assigned to each aspect of the assessment and potential source of uncertainty.
   - Figure 1. Spatial structure used in the 20XX stock assessment model.
   - Figure 2. Time series of total annual catch (1000's mt) by fishing gear over the full assessment period.
   - Figure 3. Time series of CPUE and/or other main abundance indices.
   - Figure 4. Estimated annual average recruitment (by model region, if spatial) for the diagnostic case model, including estimation uncertainty.
   - Figure 5. Estimated annual average spawning potential by model region for diagnostic case model,including estimation uncertainty.
   - Figure 6. Estimated annual average juvenile and adult fishing mortality for the diagnostic case model, including estimation uncertainty.
   - Figure 7. Plot showing the trajectories of spawning biomass and spawning biomass depletion (of spawning potential) by region including uncertainty arising from estimation, structural and intrinsic uncertainties (variability and process error).

The "Stock Status and Management Advice" section should also be structured consistently across all stocks, with a clear description of the management objectives, the performance of the stock against those objectives, and the advice provided to managers. Specifically, the following paragraph structure is recommended.

*Stock status and management advice*

(a) Describe stock assessment results compared to the previous assessment

(b) Describe management quantities for recent years related to LRP, TRP, and/or other agreed objectives with CMMs (Table 3, Figures 7 and 8)

(c) Describe projections (where relevant; Figure 9))

(d) Describe agreed recommendations based on the results of the stock assessment (possibly more than 1 paragraph; include in Table 3 summary)

- Figure 7. Majuro plot summarising the results for each of the models including uncertainty arising from estimation, structural and intrinsic uncertainties (variability and process error).
- Figure 8. Kobe plot summarising the results for each of the models including uncertainty arising from estimation, structural and intrinsic uncertainties (variability and process error).
- Figure 9. Plot showing projected stock status under recent fishing levels, including uncertainty arising from estimation, structural and intrinsic uncertainties (variability and process error).

3. **Consistent language:** In terms of uncertainty statements, the "Stock assessment and trends" section should include a summary of the main sources of uncertainty in the assessment (see next recommendation below), with a degree of confidence assigned to each aspect of the assessment and potential source of uncertainty, consistent with the IPCC guidelines for statements about evidence. A simple 3-level scale may be sufficient to achieve this - high, medium, and low confidence (Table 1). While these are not explicit probabilistic statements, they provide a useful indication of the level of confidence that the assessment team has in each aspect of an assessment.

   We note that the confidence level is not a representation of the degree of uncertainty itself (i.e., whether the uncertainty is substantial or minor), but whether the assessment outcomes adequately address the uncertainties. In a probabilistic sense, for numeric inputs and/or processes, the confidence describes the coverage that the authors believe the model has with regards to the true process. For example, a wide prior distribution on M may convey a high degree of uncertainty, but with a high confidence that this interval covers plausible outcomes, whereas a single fixed value may suggest a high degree of certainty about natural mortality, but means the likelihood of this value being exactly correct is probably low and confidence that the model representation covers the true value should probably not be high (i.e., while we may have a best guess for natural mortality, we probably do not know the true value of M). This scenario may often be the case for spatial structures or movement assumptions, where the model may be the best representation of the available data, but the true process is likely to

be more complex and building a number of alternative models may be too time intensive to be feasible within a given assessment round. An important aspect of describing uncertainties is therefore to estimate what the impact of the uncertainty is on stock assessment outcomes.

By contrast with the more subjective confidence levels applied by assessment teams to the representation of core uncertainties in the "Stock assessment and trends", the IPCC likelihood categories (Table 2) are applied in the "Stock Status and Management Advice" section. They should be applied together with corresponding probability statements to facilitate cross-cultural and contextual understanding. The latter are a direct reflection of the degree of *a posteriori* uncertainty (i.e., the total uncertainty) resulting from the assessment process. If the model is thought to adequately represent all major uncertainties (e.g., by integrating over key uncertainties in a Bayesian model or a weighted model ensemble), then the probabilities and associated IPCC likelihood categories can be directly applied to model outcomes (e.g., to the model grid). If substantial uncertainties (i.e., those likely to give a substantially wider uncertainty or different outcome) are unresolved, then probability statements should be moderated to account for unresolved uncertainties.

**Table 1:** Criteria to assign confidence in model inputs and decisions, to be applied to stock assessment inputs and decisions in the "Stock Assessment and Trends" section and associated table.

| Confidence level | Description |
|---|---|
| High | Data are representative, parameters or process well know or highly likely to be contained within prior/grid range considered |
| Medium | Some uncertainty about data representativeness, parameters/processes or unsure if fully captured in data/parameter scenarios/priors (e.g., single M may be used for technical reasons even though length-based M has been shown in literature) |
| Low | Considerable uncertainty about data/parameters/process or unlikely to be well represented in data/parameter scenarios/priors (e.g., Climate impacts, past catch unknown) |

4. **Tabulate uncertainties**: The main sources of uncertainty in the assessment should be tabulated in a consistent manner across all stocks, with a degree of confidence assigned to each aspect of the assessment and potential source of uncertainty. This will help to provide a clear summary of the main sources of uncertainty in the assessment and the level of confidence in each aspect of the assessment. This table should accompany the text description of the main sources of uncertainty in the assessment in the "Stock Assessment and Trends" section. A recommended format for the table is as follows (Table 3; A worked example for the 2024 silky shark stock assessment is given in Table 5):

**Table 2:** IPCC likelihood categories with numerical probability statements for application in the "Stock Status and Management Advice" section and associated table.

| Probability | Description |
|---|---|
| $> 99\%$ | Virtually Certain |
| $> 90\%$ | Very Likely |
| $> 66\%$ | Likely |
| 33-66% | About as Likely as Not |
| $< 33\%$ | Unlikely |
| $< 10\%$ | Very Unlikely |
| $< 1\%$ | Exceptionally Unlikely |

**Table 3:** Example of table of key main sources of uncertainty in an assessment.

| Type | Rationale | Uncertainty | Impact | Confidence** |
|---|---|---|---|---|
| **Data** | | | | |
| CPUE | Best available spatio-temporally standardised Index | Low availability of gear configuration impacting catchability | Potential hyperstability leading to over-estimating current biomass | Medium |
| **Catch** | | | | |
| Best available information | Reporting early catch | Early catch probably less impactful now; total magnitude will impact productivity estimates | High | |
| **Model** | | | | |
| Multifan CL | Standard tuna model in WCPFC | Low benchmark tested | Single model used for inference | High |
| **Spatial assumptions** | | | | |
| 9 Regions | Most parsimonious given available tags alternative spatial configurations difficult to test | Not considered | Potentially important not quantified impact unknown | Low |
| **Key parameter uncertainty** | | | | |
| M<br>steepness | Estimable given trend<br>Not estimable in present model | Estimated<br>Grid (50 Monte Carlo draws from prior derived from simulation) | Impacts estimation uncertainty<br>Impacts overall structural uncertainty | Medium<br>High |
| **Structural uncertainties** | | | | |

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**Table 3 – continued from previous page**

| Type | Rationale | Uncertainty | Impact | Confidence |
|---|---|---|---|---|
| Process error | Recruitment variability time-varying selectivity | Estimated | Potential to over-fit selectivities bias other parameter estimates | Medium |
| Movement | Best estimates from tag data | Estimated grid over assumed tag-mixing rates | Estimates driven by assumptions may not fully represent true movement process | Low |
| Time-varying selectivity | Evident in LFs | Estimated | Impacts estimation uncertainty | Medium |
| **Estimation uncertainty** | | | | |
| MCMC | Full Bayesian estimation integrating over key uncertainties (M) | Estimated | Estimation uncertainty replaces structural uncertainty for M | High |
| **Other sources of uncertainty** | | | | |
| Climate impacts | Recent recruitment may have been impacted by above-normal temperatures | Not considered | Projected biomass may be optimistic | Low |

5. **Tabulate stock status**: In addition to tabulating the main sources of uncertainty in the assessment, the stock status should also be tabulated in a consistent manner across all stocks, with a probability statement and likelihood category accompanying stock status statements. This will help to provide a clear summary of the stock status that is comparable across stocks and easily summarised across multiple stocks and over time to monitor the effectiveness of management. This table should accompany the text description of the stock status in the "Stock Status and Management Advice" section. A recommended format for the table is shown in Table 4, and a worked example for silky shark, including the use of alternative reference points, is given in Table 6. Where projections are done, the basis for projections (catch or effort scenarios should be stated).

   While the structure of the table should be standardised, the individual entries (e.g., nature of reference points/projections) should reflect the individual stock assessment and management context (see, for example, Table 6). For example, when no projections are available, this can simply be stated, and shouldn't be understood as a requirement for projections at this stage[1]. Similarly, when a management procedure is adopted, the management strategy evaluation will typically evaluate management options, and those are then defaulted to, with no need for further projections.

6. **A web-based reporting tool**: A web-based reporting app, such as the tool used to provide access to reporting by CCAMLAR, could be developed to provide a consistent and user-friendly interface for accessing stock assessment reports. This tool could allow users to easily navigate between summaries and more detailed reports, view the main results of the assessments, and access the full report in PDF format. It could also provide links to the main figures and tables in the report, as well as any supplementary material that may be available. This will help to make the reports more accessible to a wider audience, and improve the transparency and consistency of the advice provided.

[1]Nevertheless, it is recommended that projections are included in the assessment process to provide a more comprehensive view of the impact of potential management options. In this context, standardising requirements for stock assessments could be helpful to derive a consistent basis for management advice

**Table 4:** Example of a stock status table. Note, all numbers are for illustration only.

| | | | | |
|---|---|---|---|---|
| **Summary** | | | | |
| **Year: 2023** | **Biomass** | **Unlikely (<33%) to be above target** | | **Stock is overfished** |
| | **Fishing mortality** | **Likely (>66%) to be below target** | | **Overfishing is not occurring** |
| | **Projection** | **F likely (>66%) decline further** | | **Overfishing is unlikely (<66%) to occur under current catch levels** |
| | **Recommendation** | **Stock increasing towards target and F declining at current catch, no action required to reach target biomass.** | | |
| **Reference points** | | **Estimate [Lower–Upper]** | | |
| Biomass | TRP (0.4 $B_{F=0}$) | 3,000,000 t [low – up] | | |
| Biomass | LRP (0.2 $B_{F=0}$) | 1,500,000 t [low – up] | | |
| Catch | $MSY$ | 250,000 t [low – up] | | |
| Fishing Mortality | $F_{MSY}$ | 0.1 [0.08; 0.014] | | |
| **Recent estimates** | | | | **Recent trend / projection** |
| Biomass | $B$ | 1,800,000 t [low – up] | | Biomass increasing |
| Depletion | $B_{recent}/B_{F=0}$ | 0.32 [0.18 – 0.43] | | |
| Fishing mortality | $F$ | 0.08 [0.06 – 0.09] | | $F$ declining |
| Catch | $C$ | 200,000 | | Catch stable |
| **Status** | | | **Likelihood** | |
| Biomass | $B_{recent}$/TRP | 0.8 [0.65 – 1.07] | Unlikely (<33%) to be above target | |
| | $B_{recent}$/LRP | 1.65 [0.9 – 2.65] | Unlikely (<33%) to be below limits | |
| Fishing mortality | $F_{recent}/F_{target}$ | 0.8 [0.6 – 1.1] | Likely (>66%) to be below target | |
| | $F_{recent}/F_{limit}$ | 0.8 [0.6 – 1.1] | Very likely (>90%) to be below limits | |
| **Projections (basis[recent catch/effort/ alternative catch])** | | | | |
| Biomass | $B^{proj-basis}_{proj-year}/B_{MSY}$ | 0.42 [0.3 – 0.53] | About as Likely as Not (33 – 66%) to be below | $B_{proj}$ increasing |
| Fishing mortality | $F^{proj-basis}_{proj-year}/F_{MSY}$ | 0.6 [0.5 – 0.7] | Likely (>66%) to be below target | $F_{proj}$ declining |

## 5. WORKED TEMPLATE: 2024 SILKY SHARK STOCK ASSESSMENT

**Table 5:** Example of a stock status table for the 2024 Silky shark assessment. Note, all entries are for illustration only in the context of the present report and do not represent agree numbers or recommendations at the time of writing.

| Type | Rationale | Uncertainty | Impact | Confidence** |
|---|---|---|---|---|
| **Data** | | | | |
| CPUE | Observer Index | ENSO impacts lead to strong standardisation | Unclear if standardisation sufficiently removes ENSO signal from standardised index | Medium |
| **Catch** | | | | |
| Reconstructed from extrapolated observer catch-rates | Early species specific reporting; recent non-retention may lead to bias | recent catch possibly biased low; early catch highly uncertain; pre-1990 catch unknown | Medium | |
| **Model** | | | | |
| Dynamic surplus production | Most parsimonious model | Over-simplified life-history | Unknown | Medium |
| **Spatial assumptions** | | | | |
| No spatial structure | Little tagging to understand structure | Unclear | Potentially important not quantified impact unknown | Low |
| **Key parameter uncertainty** | | | | |
| Initial depletion | Estimated from informative prior | Alternative priors used to capture unknown pre 1990s catch | Highly uncertain starting point | Medium |

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**Table 5 – continued from previous page**

| Type | Rationale | Uncertainty | Impact | Confidence |
|---|---|---|---|---|
| Productivity ($R_{max}$) | Estimated from informative prior | Poorly understood a priori | Wide prior leads to high uncertainty within model runs | High |
| **Structural uncertainties** | | | | |
| Process error | Fixed | Not considered | Fits with fixed process error SD were reasonable | High |
| **Estimation uncertainty** | | | | |
| MCMC | Full Bayesian estimation integrating over key uncertainties ($R_{max}$, Initial depletion) | Estimated | Base of uncertainty grid | High |
| **Other sources of uncertainty** | | | | |
| Poor recent observer coverage | COVID driven reduction in coverage means CPUE cannot be used for 2021 and 2022 | Not considered | Most recent estimate with bioamss index is 2020 | Low |

**Table 6:** Example of a stock status table for the 2024 silky shark assessment. Note, all entries are for illustration only in the context of the present report and do not represent agree numbers or recommendations at the time of writing.

| **Summary: Silky shark** | | | | |
|---|---|---|---|---|
| **Year: 2024** | **Biomass** | No agreed target or limit for sharks | | |
| | **Fishing mortality** | **Very Likely (>90%) to be below biological reference points** | | **Overfishing is not occurring** |
| | **Projection** | No projections | | |
| | **Recommendation** | **F declining but status uncertain; maintain conservation measures.** | | |
| **Reference points** | | **Estimate [Lower–Upper]** | | |
| Biomass | - | - | | |
| Biomass | - | - | | |
| Catch | - | - | | |
| Harvest rate | $U_{lim}(notagreed)$ | 0.19 [0.09 – 0.38] | | |
| Harvest rate | $U_{crash}(notagreed)$ | 0.25 [0.16 – 0.48] | | |
| **Recent estimates** | | | | **Recent trend / projection** |
| Depletion | $N_{recent}/N_0$ | 0.44 [0.10 – 0.96] | | Abundance increasing |
| Harvest rate | $U$ | 0.017 [0.0014 – 0.048] | | $F$ declining |
| Catch | $C$ | 65 189 | | Catch declining |
| **Status** | | | **Likelihood** | |
| Harvest rate | $U_{recent}/U_{lim}$ | 0.18 [0.02 – 0.34] | Very likely (<90%) to be below limits | |
| Harvest rate | $U_{recent}/U_{crash}$ | 0.13 [0.01 – 0.25] | Very likely (>90%) to be below limits | |
| **Projections** | | | | |
| No projections | | | | |

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