2022 Scientific Consensus Statement | Process

Approach to the Consensus Process

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Contents

1. Introduction

The 2022 Scientific Consensus Statement (SCS) brings together the latest scientific evidence to understand how land-based activities can influence water quality in the Great Barrier Reef (GBR), and how these influences can be managed to improve water quality outcomes for the GBR. The SCS is updated periodically and is used by policymakers as a foundational evidence-based document for making decisions about managing GBR water quality. It is one of several projects that provide supporting information for the design, delivery and implementation of the Australian and Queensland government's Reef 2050 Water Quality Improvement Plan (WQIP). The WQIP defines objectives and targets related to water quality improvement, identifies spatial management priorities and describes actions for improving the quality of the water that enters the GBR from the adjacent catchment area.

C_2O Consulting coasts|climate|oceans was engaged by the Australian Government (Department of Climate Change, Energy, the Environment and Water, DCCEEW) and Queensland Government (Department of Environment, Science and Innovation, DESI) to coordinate and deliver the 2022 SCS, supported by a multidisciplinary group of over 70 authors and contributors with expertise in GBR water quality and evidence synthesis. An evidence synthesis expert (Evidentiary) was engaged to support the development and delivery of methods to synthesise the evidence. Oversight and quality assurance of the 2022 SCS process was provided by Australia's Chief Scientist. The Reef Water Quality Independent Science Panel (ISP) and the Reef 2050 Independent Expert Panel (IEP) had technical advisory (ISP and IEP) and review (ISP only) roles for specific steps in the process. Several expert working groups were established to support the development of methods to ensure best practice was followed for the synthesis of the evidence, peer review and consensus processes. Policy and management representatives and stakeholders, including the Reef 2050 Advisory Committee (RAC), were kept informed throughout the process.

The primary outputs of the 2022 SCS are shown in Figure 1 and are:

- The 2022 SCS Conclusions
- The 2022 SCS Summary
- The 2022 SCS Synthesis of the Evidence and high-level Evidence Statements.

These outputs follow an informal hierarchy in terms of the level of detail, moving from the full details of the **synthesis of the evidence**, to a **summary** followed by the highest-level **conclusions**.

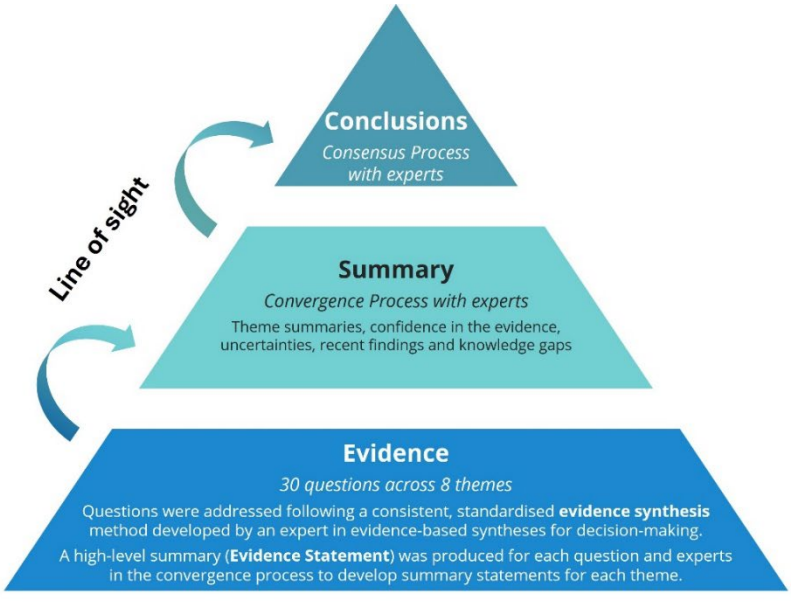

Figure 1. Main outputs and hierarchy of the 2022 Scientific Consensus Statement.

1.1 The need for a formal consensus process

Consensus methods are used to determine the extent to which experts, or a broader audience, agree about a given issue. Adopting formal consensus methods can be particularly useful when scientific evidence is intended to inform policy decisions as such methods can provide a level of confidence and assurance about the extent of agreement about specific findings. Formal consensus processes can be used to:

- Assess the extent of agreement (consensus measurement) among experts.
- Identify where there may be a lack of consensus, for example, because of limited or contradictory evidence.
- Resolve disagreement among experts (consensus development).
- Minimise personal or group bias.

Following a scoping exercise in 2021, several enhancements to the way the SCS is developed were identified by policy experts and managers, scientific experts and additional users of the SCS. In particular, the scoping exercise recognised that there was some confusion around the use of the term 'consensus' and that it was imperative that a clear definition of 'consensus' for the purposes of the SCS should be established at the start of the project.

The ISP, with further input from the IEP, settled on the following **definition of consensus**:

'*A public statement on scientific knowledge on Great Barrier Reef water quality and ecosystem condition, drawn from multiple lines of evidence, that is generally agreed by a representative group of experts. The consensus does not necessarily imply unanimity'.*

In addition, while previous iterations of the SCS had included a collective and collaborative effort among the writing teams to produce an overarching consensus statement that drew on the evidence contained in each chapter, it was agreed that the 2022 SCS required a clearly defined process for translating the evidence base into a 'consensus' output using published, widely recognised consensus methodologies.

It was recommended that, as a minimum, the development and design of the consensus process should include:

- A review of accepted methods and measures of scientific consensus/agreement.
- The capacity to elicit, handle, and communicate different levels of rigour and degrees of agreement across different topics. For example, foundational scientific evidence that has been established for many years and is quite stable may be assessed differently to evidence related to contentious, emerging, or otherwise actively investigated research.
- A mechanism for dealing with uncertainty in the agreement process.
- A mechanism for integrating measures of agreement consistent with policy decision making processes.
- Consideration of realistic timeframes and resourcing.
- Development of agreed 'criteria for success' to support the credibility, relevance, and legitimacy of processes and outcomes.

This paper describes **the detailed approach to the consensus process for the 2022 SCS Conclusions Summary documents**.

1.2 Summary of the consensus process

A range of formal methods for achieving consensus were considered during the design of the 2022 SCS consensus process. As a first step, the SCS Coordination Team (C_2O Consulting) carried out a literature review to collate information on published consensus methods. Several of the most established consensus methods were evaluated as part of the literature review including the Delphi process, the nominal group technique (also known as the expert panel), the consensus development

workshop and 'single-draft text procedure'. The review informed a draft options paper, drafted by the SCS Coordination Team, which documented the benefits and potential challenges associated with each consensus method in relation to the 2022 SCS. The paper also identified that different approaches might be necessary for the two final SCS outputs - the **Conclusions** and **Summary** documents to meet end user needs. A Consensus Process Working Group was formally established to support the development of the process. The group included three external experts with experience in the design and implementation of scientific consensus processes, as well as ISP and IEP members. A brief overview of the final consensus process is outlined below (Figure 2) with more detail in Section 3 (Design Phase) and Section 4 (Implementation Phase).

Each of the 30 questions in the Synthesis of Evidence produced an Evidence Statement that provided a succinct summary of the findings. The Evidence Statements were used as the basis for a 'Single-draft text procedure' to reach convergence on Theme-level Summary Statements, part of the **Summary** document. The convergence process involved the SCS Coordination Team drafting a Theme Summary Statement based on the Evidence Statements for that Theme. The draft Theme Summary Statement was refined by expert groups (7-9 Lead Authors and contributors per Theme) through three rounds of review and independent feedback to reach convergence among group members. Oversight and advice during this process was provided by a consensus method expert from the working group. The final step of the consensus process was to reach agreement on the **Conclusions** for the 2022 SCS. The Summary document formed the basis for the development of the 2022 SCS Conclusions, a succinct high-level document containing Overarching Conclusions and Concluding Statements for each Theme. The Conclusions consensus process involved 35 experts in an expert elicitation process, followed by an interactive consensus workshop facilitated by an external expert in translating science into policy. Additional rounds of feedback were coordinated by the SCS Coordination Team until agreement was reached by all experts, representing full endorsement of the Conclusions. The Conclusions and Summary documents were formally peer reviewed by three external independent eminent scientists and endorsed by the ISP who each reviewed the final content and examined both documents to ensure a clear line of sight to the more detailed evidence base.

This document discusses the scientific consensus process used for the 2022 SCS, involving three major phases:

- Scoping Phase: Review of relevant and accepted methods of scientific consensus / agreement for developing points of consensus, and recommendations and considerations going forward (November 2021 to February 2023).
- Design Phase: Design of the 2022 SCS consensus process (November 2022 to December 2023).
- Implementation Phase: Roll out of the consensus process for the Summary and Conclusions documents (September 2023 to March 2024).

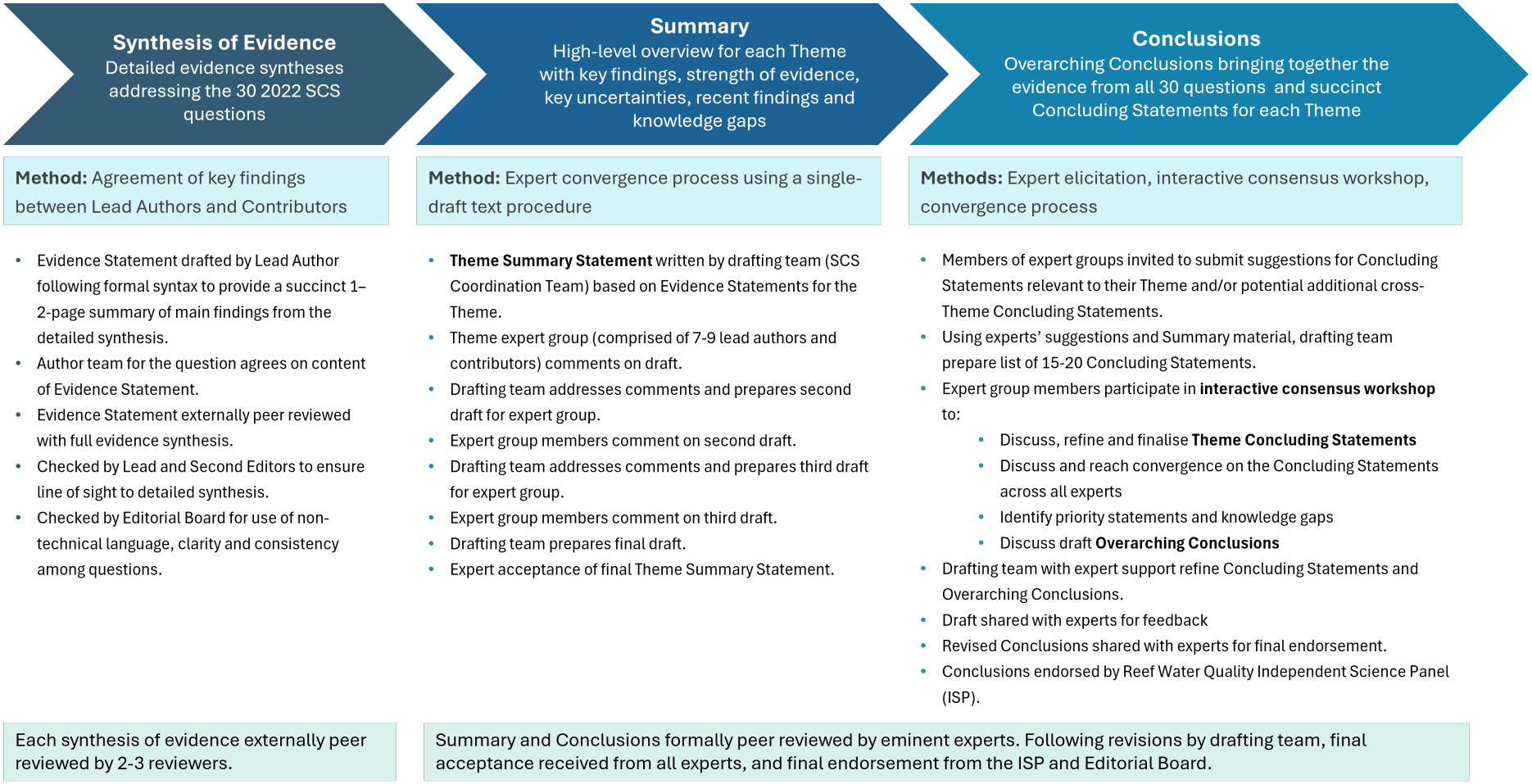

Figure 2. Consensus methods adopted for the three primary outputs of the 2022 Scientific Consensus Statement.

1.3 2022 SCS guiding principles

A set of guiding principles were developed that underpin the delivery and implementation of all aspects of the 2022 SCS process. These principles were supported and endorsed by a variety of audiences, stakeholders and end users including Australia's Chief Scientist, the ISP, IEP and the RAC. Steps to align the consensus process with these guiding principles are described below.

1. **Demonstrated independence from end users in the synthesis of the evidence and review of the outputs**.
    - Policy and management representatives were not involved in the consensus process, or review of the outputs.
    - The consensus process was coordinated by a non-governmental independent organisation, C_2O Consulting, who were appointed to lead the delivery of the 2022 SCS.
    - An independent Consensus Process Working Group was established to provide an extra layer of independence and oversight. The working group provided expert advice and guidance during the development and implementation of the consensus process.
    - Consensus Process Working Group members were appointed based on their skills and expertise in consensus/expert elicitation processes.
    - Consensus Process Working Group members completed Conflict of Interest (COI) forms and were screened prior to their formal appointment.
2. **Establish and use fit for purpose methods and processes, and engage fit for purpose experts.**
    - Following a thorough literature review, the methods selected for the consensus process were derived from a combination of existing published methods and expert input. The chosen methods provided a robust approach to capture expert agreement on scientific knowledge on GBR water quality and ecosystem condition.
    - The Consensus Process Working Group members were selected based on their expertise in consensus/expert elicitation processes.
3. **Increased transparency and robustness in design and delivery.**
    - A complete description of the design, development and implementation of the 2022 SCS consensus process is documented here and publicly available.
    - All decisions and actions relating to the design of the consensus process have been documented as part of the Terms of Reference for the Consensus Process Working Group.
    - The Overarching Conclusions and Concluding Statements were agreed by 35 experts involved in the Conclusions consensus process, endorsed by ISP, and reviewed by three independent eminent experts. All interactions and communications with experts during the consensus process, as well as feedback from ISP, eminent reviewers, and the Editorial Board, were fully documented.
    - A list of everyone involved in the consensus process is publicly available on the 2022 SCS website and in the Summary document.
4. **Minimise the potential for bias in reviewing outputs and synthesis.**
    - Each evidence synthesis in the Synthesis of Evidence (30 questions), including the Evidence Statement, was externally peer reviewed and signed off by an Editorial Board before it was used to inform the development of the Theme Summary Statements (see Sambrook & Waterhouse, 2024 for more information on the peer review process).
    - For the Conclusions and Summary documents, eminent reviewers were asked to ensure a clear line of sight between each part in terms of the evidence base and check that no new material had been introduced through the consensus process.
    - Processes incorporated to reduce the potential for bias or perceived expert bias during the implementation of the 2022 SCS consensus process included:
        - Consensus process based on a combination of published methods with input from an independent Consensus Process Working Group, while considering the criteria for

success to ensure credibility, relevance, and legitimacy of the process described in Table 2.
  - Expert groups formed by 7–9 experts (mostly Lead Authors and some contributors with specific expertise) reached convergence on the Theme Summary Statements following the 'Single-draft text procedure'.
  - 35 experts reached consensus on the Concluding Statements and Overarching Conclusions through an initial expert elicitation stage, followed by an interactive consensus workshop, and additional rounds of feedback until agreement was reached and all experts endorsed the final Conclusions.
  - All expert contributions to the consensus process had to be backed up by the evidence, and a clear line of sight was maintained between the three levels of documents (Synthesis of the Evidence, Summary, and Conclusions; Figure 1).

5. **Assess and present levels of confidence in the evidence.**
   - The underlying purpose of the consensus process was to provide confidence in the robustness, reliability, accuracy and credibility of the 2022 SCS Summary Statements and Conclusions.
   - The concept of 'confidence in the body of evidence' assessed in the Syntheses of Evidence was incorporated into the higher-level Theme statements and conclusions through an assessment of the strength of the evidence taking into account the confidence rating (based on the overall relevance and consistency of the evidence), quantity of evidence items, and diversity of study types.
6. **Ensure inclusive, genuine and timely engagement with end users, stakeholders, and audiences.**
   - Early and continued engagement with Contract Managers and other policy teams to ensure the 2022 SCS consensus process was fit for purpose and met end user needs.
   - Engagement with the Consensus Process Working Group and ISP to ensure the 2022 SCS consensus process met international best practice standards and adhered to the guiding principles.
   - Updates on the consensus process were provided to IEP and stakeholders including the RAC, and to the general public through Project Updates published on the 2022 SCS social engagement platform and via mailing lists.
7. **Improve accessibility to the science underpinning the SCS.**
   - Eminent reviewers of the Conclusions document were asked to assess if the language was suitable for a non-technical audience.
   - As part of the peer review process, either the Editorial Board, peer reviewers and/or ISP were asked to provide assurance that there was a clear line of sight between different parts of the SCS. For example, the Lead and Second Editors for each evidence syntheses were asked to check the body of evidence and the high-level Evidence Statement to ensure that all statements were supported by the evidence base.
   - The methods used to generate the three primary outputs of the 2022 SCS are available on the 2022 SCS website.

2. Scoping Phase: Options for the 2022 SCS consensus process

2.1 Background – consensus process for previous iterations of the SCS

Previous iterations of the SCS have taken the following approach to reaching consensus:

1. **Preparation of an overall synthesis chapter for the 2017 SCS** (e.g., Chapter 5, Waterhouse et al., 2017). The purpose of this chapter was to synthesise the key findings, management implications and knowledge gaps from the evidence base presented in the preceding evidence chapters. In the 2017 SCS, Lead Authors and their contributors (48 in total) used the Executive Summary for their chapter to prepare a summary of the evidence, accompanied by key points of supporting evidence and priority knowledge gaps. From these, and through consultation and discussion, the 2017 SCS writing team (11 individuals including the Lead Authors and other experts) collated the key findings and recommendations into a summary table. The summary table provided an overarching statement of consensus, a summary statement for each major theme of findings, key conclusions, and associated recommendations. Where full consensus among the writing team was not achieved, the wording of the conclusion or recommendation was modified to reflect any uncertainties or limitations to the findings.
2. **The findings in the 2017 SCS Chapter 5 were then used as the basis for the Summary Statement** which presented the overarching consensus, and the eight main conclusions from the supporting evidence base.
3. **External peer review of the 2017 Summary Statement by two external eminent scientists.** The reviews focused on improving the clarity of wording.

2.2 Approach for developing the 2022 SCS consensus process

As part of the SCS Planning Project undertaken in 2021, the policy and expert consultation forums agreed that a clear process was required for **defining and reaching consensus**, including who should be involved. Three major steps were identified:

1. Definition of 'consensus' relevant to the Scientific Consensus Statement, including deciding the extent/degree of consensus required. Key considerations included the purpose of consensus, who decides, and how to manage issues if full consensus was not achieved.
2. A robust process to determine and report the degree of consensus for emergent key findings.
3. A clearly defined process for translating from the evidence base to the 'consensus' output.

The **definition of consensus** agreed by the ISP and supported by the IEP in the context of the 2022 SCS was:

"A public statement on scientific knowledge on Great Barrier Reef water quality and ecosystem condition, drawn from multiple lines of evidence, that is generally agreed by a representative group of experts. The consensus does not necessarily imply unanimity."

Regarding the **process of developing consensus**, ISP also noted that:

"During the development of consensus, comments and objections are considered using fair, impartial, open, and transparent processes using all the best available, peer reviewed and publicly available science from a range of disciplines."

Table 1 below describes the three main stages that required some degree of agreement or consensus in the 2022 SCS based on policy feedback.

Table 1. Stages requiring some degree of consensus in the 2022 SCS, organised by the three primary outputs.

Stages	Description and Agreed Approach
Syntheses of Evidence and Evidence Statements	**30 x Syntheses of Evidence** prepared by Lead Authors and contributors, with guidance/quality checks from the SCS Coordination Team, and externally peer reviewed. **Evidence Statements** (with key supporting points) and associated confidence level prepared by Lead Authors (as part of the Synthesis of Evidence), with guidance from the SCS Coordination Team. **Agreement required within author team.**
Summary and Summary Statements	The SCS Coordination Team to prepare Theme-level Summary Statements based on the Evidence Statements for the Theme. **First level of consensus (or 'convergence')** sought from groups of Lead Authors and contributors involved in each Theme. ISP to review the Summary.
Conclusions and Concluding Statements	SCS Coordination Team to draft based on the Summary document followed by a formal consensus process with Lead Authors and contributors. ISP advice to finalise, and final review by eminent experts – **Second level of consensus**.

The development of a scientific consensus process to suit the 2022 SCS required an iterative approach with input from the ISP, the IEP, Contract Managers (DCCEEW and DESI) as well as other experts and science representatives. Following the review of an initial draft paper on the 2022 SCS consensus process prepared by the SCS Coordination Team (C_2O Consulting), it was decided in consultation with ISP, IEP, and Contract Managers that an expert working group should be established to provide expert input to the full development of the process. This working group should include members from the ISP, IEP, and at least one expert in consensus processes**.**

Additional detail on the key steps in the development of the SCS consensus process are detailed in Appendix 1.

2.3 Potential methods for the 2022 SCS consensus process

To scope the proposed consensus process for the 2022 SCS, the SCS Coordination Team reviewed the literature for examples of scientific consensus methods and considered how they might meet the needs of the 2022 SCS. From this review, it was recognised that different approaches might be required for the two final SCS outputs – the **Conclusions** and **Summary** documents, to meet end user needs. The availability of time and resources was also a major consideration.

Based on the scoping exercise and the results of the literature search (including options from the Great Barrier Reef Marine Park Authority consensus workshop to inform the 2019 Outlook Report; Harper, 2019), the following methods were researched further and considered in terms of applicability for the 2022 SCS:

- Delphi method
- Investigate, Discuss, Estimate, Aggregation (IDEA) method
- Nominal Group Technique / Expert Panel method
- Consensus Development Panels/ Conferences/ Workshops
- RAND/UCLA Appropriateness Method (RAM)
- 'Red Team-Blue Team' exercise
- Focus Groups
- 'One-Text' or 'Single-Draft Text' Procedure

A brief description of each method, including considerations for timeframes and resources, and an assessment of the overall suitability for the 2022 SCS is presented in Appendix 2, Table A2. The four

methods identified as potentially suitable for the 2022 SCS included the Delphi method, the Expert Panel method, the Consensus Development Workshop, and the 'One-Text' or 'Single-Draft Text' Procedure (Table 2). It was acknowledged that a combined approach using multiple methods might be required to reach consensus for the different parts of the 2022 SCS (see Section 3 and 4 for recommendations; Figure 1).

Table 2. Summary of pros and cons for the four methods of consensus suggested as potentially suitable for the 2022 SCS.

Method name	Pros	Cons
1. Delphi method (online) (Cam et al., 2002; Jones & Hunter, 1995; O'Hagan, 2019; Waggoner et al., 2016)	• Anonymous responses, so less risk of bias and influence of opinions. • No face-to-face needed (less expense). • Multiple rounds ensure thoughtful consideration of opinions. • It would enable participation of a broader group of international/national experts.	• Requires online platform and process set up. • More impersonal. It limits the opportunity for discussion among participants. • It requires multiple rounds and participants answer at their own pace, so it could take several months.
2. Nominal Group Technique / Expert Panel Method (Jones & Hunter, 1995; Raine et al., 2014; Waggoner et al., 2016)	• Time efficient and relatively fast, as expert group is kept focused on a specific task. • Opportunity for expert discussion face-to-face. • Could be combined with an online phase to reach initial agreements, followed by group discussion.	• It can be expensive and complicated to organise (venue, organisation, etc.). • Risk of influence or bias during face-to-face discussions.
3. Consensus development Panels/Conferences/ Workshops (Garner et al., 2016; Rhodes et al., 2020; Waggoner et al., 2016)	• Opportunity for expert discussion face-to-face. • More transparency. • Could be combined with an online phase (or previous expert panels) to reach initial agreement, followed by group discussion.	• It can be expensive and complicated to organise (venue, organisation, etc.). • Risk of influence or bias during face-to-face discussions. • Might require initial preparation of points of consensus, to focus the conversations.
4. 'One-Text' or 'Single-Draft Text' Procedure[1,2] (Fisher et al., 2011; Simmons 2022)	• Allows convergence towards agreement in an efficient and relatively fast manner, as expert groups are kept focused on a specific task. • All drafting responsibility lies in the hands of a single drafter or drafting team, while experts are involved in providing feedback to improve a single draft.	• Impersonal. It limits the opportunity for discussion among participants although it could be combined with an (online or in person) meeting if needed to finalise discussions. • It might require multiple rounds of comments but could be kept to 2-3 weeks maximum if return times are quick between drafting team and experts.

[1] One-text procedure
[2] Single-text negotiation

2.4 Additional considerations

Handling and communicating different levels of rigour and degrees of agreement across products

Each **synthesis of evidence** for the 30 questions includes an assessment of the confidence associated with the evidence for the question, based on the relevance and consistency of the body of evidence. This was prepared by the Lead Author and their team and included in the peer reviewed products. A visual output summarises this information for each question, accompanied by a table summarising all evidence appraisal results for the question (including other indicators such as quantity and diversity of the evidence, and an additional Quality Assessment statement for the 2022 SCS Evidence Reviews). Figure 3 presents an example of this visual output of the confidence assessment.

For the **Conclusions and Summary** documents, it was initially suggested that a comparable measure of confidence could be estimated based on the confidence levels of all individual questions used to address each overarching Theme. However, this was likely to require additional work, depending on the complexity of the inputs, and the outputs of the Conclusions and Summary could not depart too far from the peer reviewed outputs in the Synthesis of Evidence.

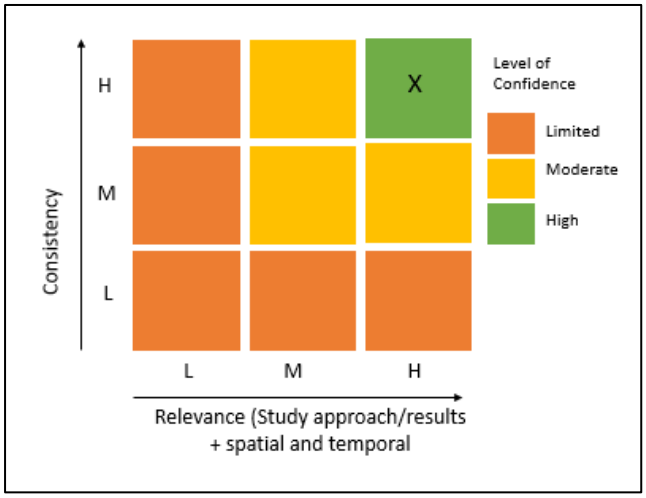

Figure 3. Matrix representing the overall level of confidence in the body of evidence (i.e., Limited, Moderate and High). In this example, relevance and consistency are rated 'High' and therefore the confidence in the body of evidence would be High.

Mechanisms for dealing with uncertainty in the agreement process

Drawing on the methods reviewed, different mechanisms for dealing with uncertainty in the agreement process were identified. For instance, in a Delphi exercise, consistency algorithms determine how well the expert opinions converge at the end of each round. If the pre-specified convergence criterion has not been met, the results of the round are then fed back to the experts and the process is repeated until convergence is met, or a specified number of rounds have been completed. In some situations, there could even be a round of face-face discussions to resolve specific uncertainties or ambiguities in the wording of the survey. When polling is complete, results are reported to the author with statistics including the number of rounds to converge and the level of consensus. Agreement with statements is usually summarised by using the median and consensus assessed by using interquartile ranges for continuous numerical scales. The researcher undertaking the study may ask participants that have been identified as outliers to provide written justification for their responses.

For the nominal group technique, rules have been developed to assess agreement when statements have been ranked on a 9-point scale, for example, with scores 1–3 indicating that participants do not feel an intervention (i.e., or management measure or recommendation) is necessary, 4–6 participants are undecided, 7–9 participants feel intervention is required. If all ratings fall within one of these predefined regions, it is considered to be strict agreement. Another rule tests whether extreme rankings are having an undue influence on the final results and consists of including all ratings for each statement and then by excluding one extreme high and one extreme low rating for each statement and checking results again (Jones & Hunter, 1995).

For the 2022 SCS process, it was essential to document any disagreement among experts when discussing the specific wording of each statement and its associated confidence level.

Criteria for success to ensure credibility, relevance, and legitimacy of the process

A review of consensus methods for best practice by Waggoner et al. (2016) provided a number of recommendations about how consensus should be approached to be successful. The review recommended:

- Researchers should clearly describe their inclusion criteria to ensure the process is transparent (e.g., how participants were chosen; the criteria used to determine how and when consensus was met).
- A panel of 5–11 members is optimal across most consensus methods.
- Statistical analysis for consensus methods should be as rigorous as possible (i.e., to determine which items should be re-examined in subsequent rounds when using the Delphi method).
- The predetermined definition of consensus must be included in the final report (Waggoner et al., 2016).

Additionally, another review (De Boeck et al., 2014) recommended that to develop trustworthy guidelines/consensus, rigorous criteria must be adhered to, such as transparency in all aspects of the guideline/consensus development, multidisciplinary panel composition, and reliable grading of evidence for the recommendations (Table 3).

Table 3. Standards for trustworthy guidelines from the Institute of Medicine (De Boeck et al., 2014).

Domain	Specific standards
Transparency Conflict of interest	Funding and development process should be described and made public. All conflicts should be disclosed. Chair/co-chair should not have COIs. Majority of panel should not have COIs. Members with financial conflicts should divest. Funders should not play a role in development.
Panel composition	Panel should be multidisciplinary. Panel should include patient or patient advocate.
Literature review	Evidence synthesis should adhere to Institute of Medicine standards for trustworthy systematic reviews. Evidence review and guideline development teams should work separately but interact.
Grading of recommendations	Systematic approach should be used to summarise benefits and harms, rate the quality of the evidence, grade the strength of recommendations, incorporate values and preferences, and acknowledge differences in opinion.
Articulation of recommendations	Use standardised format, e.g., PICO. Strong recommendations should be measurable.
Review process	Review should be confidential. Review should be performed by diverse stakeholders. Draft should be available for public comment.
Assessment of currency and updating	Dates of systematic review and publication should be stated. Literature should be monitored and guideline updated when indicated by availability of new evidence.

Definitions of abbreviations: COI = conflict of interest; IOM = Institute of Medicine; PICO = population, intervention, comparator, outcomes.

2.5 Recommendations from the Scoping Phase

Following discussions with Contract Managers and ISP on consensus options (documented above), it was agreed that a consensus process based on combined methods should be designed for the 2022 SCS, including some components from the methods presented above. Potential approaches for further consideration included an initial assessment of statements within sub-groups of Lead Authors and contributors organised by Themes (e.g., using the Expert Panel method, online or in person, a Consensus Development Workshop, or the 'One-Text' or 'Single-Draft Text' Procedure), followed by an online Delphi method (or alternatives, to be discussed) to achieve wide national and/or potentially international endorsement of the final points of consensus (*this was subject to further discussion later in the development of the consensus methods*).

3. Design Phase: 2022 SCS consensus process

This phase covered the formation of a Consensus Process Working Group and the design and development of the consensus processes used in the 2022 SCS. Additional detail on the key steps involved in the design phase is presented in Appendix 1.

3.1 Forming the Consensus Process Working Group

Following the review of a draft options paper for the 2022 SCS consensus process prepared by the SCS Coordination Team, it was decided in consultation with the ISP, IEP, and Contract Managers that an expert working group should be established to provide expert input to the full development of the process. It was agreed by DCCEEW and DESI Contract Managers, with support from the Reef 2050 WQIP Executive Steering Committee, that the Consensus Process Working Group should include representatives from the ISP and IEP. It was also agreed in further discussions between the SCS Coordination Team and Australia's Chief Scientist that there should be at least one external member with specific expertise in consensus processes.

To maintain transparency, each nominee/applicant was considered against the criteria specified below. Members were required to meet Criteria 1 and 2 and at least one of the remaining three criteria (Criteria 3–5).

Essential:

- **Criteria 1:** Availability to participate from December 2022 until November 2023, with the peak period for Consensus Process Working Group activity from February to May 2023 (design phase) and September to November 2023 (implementation phase).
- **Criteria 2**: Demonstration that any potential conflicts of interest, identified through completion of the Conflict of Interest Declaration and assessed against the Conflict of Interest Policy, can be mitigated.

At least one of these criteria:

- **Criteria 3:** Current ISP or IEP member, with some expertise in the subject matter of the SCS.
- **Criteria 4:** Experience using expert elicitation or consensus methods in environmental reporting, monitoring or science programs.
- **Criteria 5:** Experience designing or facilitating consensus processes or expert elicitation.

The **selection of members** is described below.

1. In July 2022, the SCS Coordination Team sought **nominations from the ISP and IEP** for two members from each Panel to participate in the Consensus Process Working Group. These members were to provide advice and make decisions on behalf of their respective advisory committees. Two nominations were received from ISP and one nomination was received from IEP:
    - Roger Shaw (ISP) [From January 2023, Roger became an external expert, as no longer a member of ISP]

- Andrew Ash (ISP)
- Kerrie Wilson (IEP) [no longer a member of the Working Group once appointed as Queensland's Chief Scientist in November 2023]

2. Approach to **external expert(s) with experience in the design and implementation of scientific consensus processes**. Nominees were considered against the criteria listed above to ensure they met the requirements for this group. The external experts appointed were:
   - Trevor Ward (Greenward Consulting)
   - John Cook (University of Melbourne)
   - Daniel Druckman (George Mason University)

3.2 Role of the Consensus Process Working Group

The **Terms of Reference for the Consensus Process Working Group** were agreed by members at their first meeting and are available upon request. In summary, the role of the Working Group was to:

- Ensure that all aspects of the 2022 SCS consensus process aligned with the 2022 SCS guiding principles (i.e., transparency, minimise bias, confidence, independence, fit for purpose, accessibility, and engagement).
- Provide guidance and technical input to the design and delivery of the consensus process to ensure that the consensus process met best practice standards and to provide assurance about the quality and integrity of the final consensus outputs.
- Advise on the criteria and selection of experts to be engaged in the process.
- Endorse the final design and delivery of the consensus process from a technical perspective.

The topics discussed and agreed by the Consensus Process Working Group are summarised in Table 4 (Actions 1 to 9). The decisions and actions were primarily associated with who should be involved in the process, whether a confidence assessment was appropriate at each level of detail (from Synthesis of Evidence to the Conclusions), and options for the consensus or endorsement process. The final agreed approach is presented in Section 4.

Table 4. Summary table of actions and decisions as part of the development of the 2022 SCS consensus process.

Action	Decision or Action required	Consensus Process Working Group Advice
2022 SCS Syntheses of the Evidence – Evidence Statements		
1	Note the proposed syntax for the Evidence Statements for each question, and suggest any required improvements (if relevant).	• Try to incorporate replication/multiple lines of evidence where possible (even if in a case-by-case scenario, based on applicability to the question). • Instead of using the word 'consensus' at this level, use 'agreement'.
2022 SCS Summary – Summary Statements		
2	Confirm **who could participate in the first level of consensus/convergence**, presently proposing Lead Authors involved in each Theme/Topic, separately, to ensure appropriate expertise and optimal size of the group, for each statement.	• SCS Coordination Team to lead and coordinate the process (as the '*drafting team*'). • Compose Theme expert groups: - 7-9 experts is considered a good number for the author groups (trade-off between credibility/efficiency). - Combine Lead Authors for questions within Themes, or if need to expand the group to meet recommended minimum number of experts per Theme, seek relevant expertise outside of the Theme Lead Authors (e.g., Contributors).
3	Provide advice on preferred method for first level of consensus/convergence: • Options for small expert panels/consensus workshops, 'Single-draft text procedure' • Virtual or in-person • How to resolve disagreement between experts • Any other requirements?	• Agreed that the '**Single-draft text procedure'** seems appropriate for this step, which involves: - The *drafting team* drafts the document (based on a pre-defined structure), including (Theme) Summary Statements, and (Topic) Summary Tables (*TBC*). - 'Drafts' prepared by the drafting team are shared online with relevant expert groups, to comment ('bracketing'), based on the 'evidence' (avoiding personal preferences). - The *drafting team* considers all comments and prepares another round (2–3 iterations might be needed) until everyone is comfortable with the agreed text. - Within an expert group, all authors are allowed to see everybody else's comments after each round. However, if discussion is needed, it should be channelled through the *drafting team*.

Action	Decision or Action required	Consensus Process Working Group Advice
		- Engagement with the document to be tracked so everyone provides feedback/agrees with the rest. - If convergence is still not reached after 2–3 iterations, the most 'conflicting' points could be discussed with the experts and/or moved into an 'uncertainties and limitations' section of the statement, if needed. • In this context: - SCS Coordination Team (i.e., *drafting team*) to lead and coordinate the process. - Theme Statements to be drafted for each Theme by the *drafting team* and reviewed by each Theme expert group until agreement/ convergence between Theme experts is reached. - ISP review and provide advice, if required. Further detail of the final approach is included in Section 4.
4	Provide advice on how to deal with **Evidence Statements with lower Confidence** (if this arises)? Should all Evidence Statements be considered in the preparation of the Theme Summary Statements regardless of their confidence level, or should the ones with 'low' confidence be moved to the 'areas of uncertainty requiring further work' section?	• Lower confidence statements should still be part of the material in the Summary, as they tell part of the story, and it could look incomplete without them.
5	Discuss if it is appropriate to **estimate a confidence level** for the Theme Summary Statements based on the confidence level of the individual Evidence Syntheses, and if yes, how would this be developed. An alternative option is to only have confidence levels assigned at the question level, and provide a narrative description of the strength of evidence for each Theme and Topic.	• Supported the alternative option of confidence levels assigned at the question level, with a narrative description of the strength of evidence for each Theme and Topic. • There was also support for carrying the confidence levels from the questions up to the statements, if possible (i.e., similar to the IPCC Summary for policymakers which shows the line of sight back to the evidence).

Action	Decision or Action required	Consensus Process Working Group Advice
2022 Scientific Consensus Statement: Conclusions – Concluding Statements		
6	Confirm **who participates** in the second level of consensus (i.e., Lead Authors contribute to specific statements (by topics of expertise) and review overarching statement? ISP reviews and finalises?).	• SCS Coordination Team (i.e., *the drafting team*) to lead and coordinate the process. • All members of the expert groups (as per Appendix 3) are invited to submit suggestions for Concluding Statements relevant to their Theme expert group, and additional Topic Concluding Statements. • All experts (i.e., Lead Authors and some contributors, as per Appendix 3) to meet in an interactive workshop to finalise the draft Concluding Statements. • An expert in communications could assist if needed to ensure the Concluding Statements are fit for their purpose. • ISP reviews and provides advice. • Eminent Reviewers review. • Policy can have a say in the structure of the Statements, to ensure they meet their needs, but not in the actual content or review. Working Group maintains oversight role.
7	Provide advice on **preferred method for second level of consensus** (e.g., small expert panels/consensus workshops? Delphi process? 'Single-draft text procedure'?)	• Expert Elicitation process at the end of the **Summary** Convergence Process, for experts to propose Concluding Statements relevant to their Theme expert group and potential Topic Concluding Statements. • *Drafting team* collates and prepare list of draft Concluding Statements. • Interactive workshop with all experts involved in the **Summary**, to reach consensus on final list of Concluding Statements and Overarching Statement. - ISP reviews and provides advice. - *Drafting team* finalises and seeks ISP endorsement. - Final acceptance of all Concluding Statements by all experts. - Final review by Eminent Experts (suggested to have 3 to moderate potential disagreement). Further detail of the final approach is included in Section 4.

Action	Decision or Action required	Consensus Process Working Group Advice
8	Discuss if it is appropriate to estimate a confidence level for the Concluding Statements (based on the confidence level of the individual Evidence Synthesis, or by undertaking a separate expert elicitation process). *Note: Policy teams did not have a final position on this but did express some concern associated with the risks of 'rolling' up confidence from underpinning questions to be associated with higher level statements, and the need to provide a strong and transparent basis for the final confidence ratings. A narrative of the overall strength of evidence might be more appropriate, noting the areas of evidence with greatest confidence, and those with lowest confidence.*	• Agreed that each Concluding Statement does not need to carry the confidence level from the Questions. • A summary narrative could be presented of the overall strength of evidence (i.e., areas of evidence with greatest/lowest confidence).
2022 Scientific Consensus Statement: Conclusions – Endorsement of 'Concluding Statements' by Broader Expert Group (TBC)		
9	Provide advice on the overall appropriateness/feasibility of this high level 'endorsement' by a broader group of experts (considering no further modifications of statements will be allowed after products have gone through peer review by eminent experts) and if so, consider at which level it should take place (i.e., for all the Concluding Statements, or only for the high-level 'Overarching Statement'?) *Note that policy teams were initially very keen to seek broader endorsement of the Concluding Statements, but it was also recognised that this could be done as part of the Communication Phase later on.*	• Australia's Chief Scientist was not supportive of the proposal to seek broader expert endorsement following eminent review. • Contract Managers and Consensus Process Working Group agreed that this could be left for the Communication Phase of the project. *As of January 2024, it was agreed that this will not be progressed due to limited resources.*

4. Implementation Phase: Final methods and delivery of the 2022 SCS consensus process

The final consensus process for the 2022 SCS met most of the original success criteria identified to ensure credibility, relevance and legitimacy of the process including:

- Transparency of process development.
- All conflicts of interest for anyone involved in the consensus process were disclosed, properly managed (if needed), and funders did not play a role in the design or development of the process.
- Multidisciplinary panel composition at the various levels of agreement/convergence/ consensus.

The consensus process for the 2022 SCS was finalised with input from the Consensus Process Working Group and approved as being fit for purpose by Contract Managers. Instructions for the Summary and Conclusions consensus processes were shared with all experts involved before each process was rolled out.

The final approach implemented for the three primary outputs is detailed below.

4.1 Synthesis of the Evidence - Evidence Statements

- Lead Authors and contributors prepared Evidence Statements (and supporting points) as part of the synthesis for each question, using the syntax below (~1,000 words in total).

  > The synthesis of the evidence for **Question <x.x>** was based on <number of studies> undertaken in <location of studies used> and published between <period of studies used>. The synthesis includes a <diversity rating> diversity of study types (<type of studies used / lines of evidence>) and has a <confidence rating> confidence rating (based on <consistency rating> consistency and <overall relevance rating> overall relevance of studies).
  >
  > **Summary of findings relevant to policy or management action**
  >
  > <summary finding relevant to policy or management action - not more than a few sentences>.
  >
  > **Supporting points**
  >
  > - <Points to substantiate text above, covering variability relevant to policy and management such as between regions, land uses, ecosystems and reference to multiple lines of evidence>
  > - <Include point of key recent findings/new knowledge, if applicable>

- The Evidence Statements did not require an official 'consensus process'. Instead, the Lead Authors and contributors involved in that question were required to reach 'agreement' in the development of the Evidence Statements.
- The Evidence Statements were externally reviewed as part of the peer review process for the Synthesis of Evidence. A Lead and Second Editor provided assurance that there was a clear line of sight between the body of evidence and the high-level Evidence Statement to ensure that all Statements were supported by the evidence base. The Editorial Board then collectively checked the Evidence Statements for use of non-technical language, clarity, and for inconsistencies among questions, and signed them off once satisfied.

4.2 2022 SCS Summary – Theme Summary Statements

The purpose of the Summary document was to provide a high-level overview for each Theme. Each Theme Summary Statement included an overarching statement for each Theme, key findings, a narrative description of the overall strength of evidence (noting the areas of evidence with greatest confidence, and those with lowest confidence), key uncertainties, recent findings and knowledge gaps relevant to policy. Producing the Theme Summary Statement required an expert convergence process.

The method selected for this expert convergence process was the '**single-draft text procedure'**[3]. This procedure consists of various iterations of commenting/editing a draft text prepared by a drafting team, with input from an '*expert group*'. For the 2022 SCS, five *expert groups* were formed which included the Lead Authors of the Synthesis of Evidence questions and several contributors with specific expertise (i.e., 7-9 members in each *expert group*). Organisation of the Themes and *expert groups* is presented in Appendix 3.

The **method applied** for the Theme Summary Statements consisted of the following steps:

1. The SCS Coordination Team acted as the '*drafting team'* to draft one Summary Statement per Theme (or merged Themes), using a pre-defined structure (as per syntax below, approximately 1–2 pages) and based on the individual Question Evidence Statements and supporting materials (i.e., Synthesis of the Evidence). Note that at the start of each Theme section there is a short description of the Theme to provide context and a representative conceptual model. Experts were invited to comment on these before finalisation but these were not included as part of the convergence process.

   > The **synthesis of the evidence** for **Theme <xx>** included a total of <number of studies> studies extracted and synthesised for <number of questions> questions.
   >
   > The **summary findings** relevant to policy or management action for **Theme <xx>** are:
   >
   > *<Main summary of findings relevant to the Theme presented as dot points with Question source identified in brackets for each point> (1–2 page maximum)>*
   >
   > The **confidence rating** of the questions was <Confidence range e.g., High-Moderate, or Moderate-Low, or mostly Moderate with only xx questions rating Low>.
   >
   > The findings in this Theme are underpinned by a <qualifier (e.g., large)> body of evidence, including <describe consistency, longevity of key concepts, and/or multiple lines of evidence?>. The **strength of evidence** across this Theme is considered to be <e.g., Low, Moderate or High?> with the exception of xxx.
   >
   > The **key uncertainties** of the evidence for **Theme <xx>** relevant to policy/management included…
   >
   > **Recent findings** (since the 2017 Scientific Consensus Statement) has/shows/demonstrates etc xxx
   >
   > Within **Theme <xx>,** the areas where **further knowledge is needed** that are most relevant to policy and management include: xxx

2. The 'draft' prepared by the *drafting team* for the Summary Statements was **shared** online (via email) with each *expert group*.

[3] One-text procedure and single-text negotiation

3. Experts were **invited to comment** within one week on the content of the draft, adding any points of disagreement/proposed improvements to the text in comments, based on the 'evidence'.
    a. Any suggested changes to the content had to be supported by evidence and the expert had to refer to the relevant Question source.
    b. Comments that focused on writing style were avoided.
    c. If experts decided not to comment on the draft, this was considered as 'agreement' with the proposed version, but they were still able to comment in subsequent rounds. **All contributions were recorded by the *drafting team*.**
4. The *drafting team* considered all comments and prepared **a second draft** for consideration by *expert groups*, following the same process as per the initial draft (Step 3a to c).
    a. During the feedback process, experts had access to all feedback, but it was recommended not to engage in discussions between experts through the comments. Instead, any issues were to be raised with the *drafting team* to consider during the review process.
    b. If convergence was still not reached at this stage, any points of disagreement were discussed with the contributing expert(s). If still not resolved, the points were moved into the 'uncertainties and limitations' section of the Statement, or framed to reflect the issues.
5. The *drafting team* considered all comments and prepared **a third draft** for consideration by *expert groups*, following the same process as per the initial and second draft.
6. The process required **three rounds of commenting/editing** to reach convergence among the experts, and it was completed within one month.
7. The *drafting team* prepared the **final draft** and circulated to the *expert group*. Acknowledgement of acceptance of the final draft was provided by all participants in the *expert group* via email.
8. Once finalised, **ISP reviewed the whole Summary document** and provided additional advice (i.e., October 2023).
9. The *drafting team* considered ISP feedback and finalised the 2022 SCS Summary with assistance from the *expert group* where required. The final version was circulated to the *expert group* for noting.
10. At the completion of the 2022 SCS Summary convergence process, all members of the *expert groups* were invited to submit suggestions for Concluding Statements relevant to their Theme *expert group*, and potential additional Concluding Statements that could be informed by more than one Theme (clearly distinguished as 'cross-Theme' inputs).
    a. The structure of the Concluding Statements was guided by the provision of 'mock' examples prepared by the *drafting team*.
    b. Each *expert group* was limited to a maximum of three suggested Concluding Statements related to the Theme, and two additional Concluding Statements. In some cases, experts submitted their suggestions individually and these were collated.
    c. The draft Concluding Statements for each *expert group* were progressed as part of the Conclusions consensus process.

The whole convergence process for the Summary document was completed within six weeks (i.e., mid-September to late October 2023), and overall, there was a very positive response from the expert groups. All experts participated in at least one round of editing and indicated acceptance of the final draft. Daniel Druckman (Consensus Process Working Group) provided advice and support throughout the process.

4.3 2022 Scientific Consensus Statement Conclusions - Concluding Statements

The 2022 SCS Conclusions includes the Overarching Conclusions (a few succinct points) and a short list of Concluding Statements for each Theme. The Conclusions document provides the highest-level overview of all the evidence collated and analysed as part of the 2022 SCS and identifies the key messages and main conclusions that can be derived from the evidence base. The Conclusions document also includes information on the strength of the evidence, new knowledge since the 2017 SCS and some of the key knowledge gaps.

The method selected to reach Consensus at this highest level was a combination of expert elicitation, an interactive consensus workshop, and refinement and final acceptance by all 35 experts involved in the preparation of the Concluding Statements (same experts from the Summary convergence process, Appendix 3).

The method applied for the **Conclusions** consisted of the following steps:

1. As per point 10 above, at the completion of the Summary convergence process, all members of the *expert groups* were invited to submit suggestions for Concluding Statements relevant to their Theme and potential additional Concluding Statements that could be informed by more than one Theme (i.e., 'cross-Theme' inputs). Specific instructions to experts included:

   - *From the evidence in your Theme(s), what are the **three most important evidence-based conclusions that you think need to be made to policymakers**? Please consider the full scope of your Theme in your response, not just your question. These concluding statements need to be succinct and clearly linked to the Theme Summary Statement (and synthesis of evidence).*

   - *The idea of the cross-theme statements is to capture the issues that emerge across and between Themes that should be highlighted to policymakers, for example, covering a particular land use or ecosystem in the context of multiple pollutants. From your work in the Theme/s and your review of the other outputs across the Themes, **what are the top two cross-theme conclusions from the collective evidence in the Summary document, the SCS process and/or any emerging issues** that you think need to be highlighted to policymakers? Please be able to justify your choice with evidence from the Summary document.*

     *To make the process more efficient, **please share your ideas with the whole Theme expert group by 'replying to all'**, so we can build on each other's suggestions, if relevant.*

     The SCS Coordination Team provided experts with a mock example derived from Themes 1 and 2 to assist in getting started with the drafting process.

2. Using the experts' suggestions and Summary material, the *drafting team* prepared a consolidated list of 15–20 Concluding Statements. The list was circulated to all experts for written feedback in preparation for the consensus workshop (Step 3).

3. All participants from the *expert groups* from the Summary (35 experts) were invited to participate in an **interactive workshop** in November 2023 (in person but online options were also available).

4. The draft list of Concluding Statements was presented and discussed at the consensus workshop with all *expert groups* with the aim to:

   i. Discuss, refine and finalise **Concluding Statements** for each **Theme** (grouped by the *expert groups* used in the Summary convergence process).
   ii. Discuss and reach convergence on the **Concluding Statements** across all experts**.**

iii. Identify any additional cross-Theme Concluding Statements and test them with all experts. Identify priority statements to be included.
iv. Identify priority knowledge gaps.
v. Collectively discuss the draft **Overarching Conclusions**.

5. The *drafting team* compiled the workshop outputs and shared with a small group of experts that volunteered to assist in refining the Concluding Statements and Overarching Conclusions. The proposed cross-Theme Concluding Statements discussed at the workshop were largely incorporated into the Overarching Conclusions.
6. An improved draft list was then shared with all experts via Google docs for additional feedback. Input was limited to points of clarification of technical content.
7. The drafting team collated all feedback and compiled the **Conclusions**, which was then shared with all experts for their final endorsement (via a Survey Monkey poll).
8. Once finalised and endorsed by all experts, **ISP reviewed the draft Conclusions** and provided advice. Clarification from *expert groups* was sought by the *drafting team* if required.
9. *Drafting team* finalised the Conclusions and **sought ISP endorsement**.
10. **Final Review** of the **Summary** and **Conclusions** documents by **eminent experts**.
11. The Editor-in-Chief gave preliminary endorsement of the revised **Summary** and **Conclusions** following eminent expert review. Revisions were completed by the *drafting team*.
12. *Drafting team* sought **final acceptance of revised draft from all experts** (via a Survey Monkey poll).
13. **Final endorsement** of the **Summary** and **Conclusions** documents by the Editorial Board and ISP.

The initial consensus process (points 1–9) was completed in seven weeks approximately (late-October to mid-December 2023), followed by 2.5 months of eminent expert review, addressing comments, and obtaining final endorsement from experts, the Editorial Board and ISP (January to March 2024).

All experts commented on the Concluding Statements and Overarching Conclusions at some point and endorsed the final draft and revised version of the Conclusions document.

The Overarching Conclusions and Concluding Statements were agreed by 35 experts involved in the Conclusions consensus process, endorsed by ISP, and reviewed by three independent eminent experts.

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Appendix 1: Key steps in the SCS consensus process development

Table A1. Steps in the process of developing the 2022 SCS consensus process.

Steps	Description
Scoping phase	
1. Scoping exercise (early 2021) [4]	Agree minimum requirements of the consensus process and definition of consensus in the context of the 2022 SCS. Endorsed by ISP and supported by IEP.
2. Literature review and options paper, drafted by the SCS Coordination Team (December 2021 to February 2022)	SCS Coordination Team reviewed the consensus methods literature to summarise information into an options paper on potential consensus methods and how to apply to the process to the 2022 SCS.
3. Feedback on options paper by DCCEEW and DESI Contract Managers (February 2022)	No specific comments received from DCCEEW. DESI requested clarification about how points of consensus with lower confidence or inconclusive would be handled.
4. Main steps in the proposed process provided to IEP meeting (28 February 2022) and ISP meeting (2 March 2022)	No specific comments provided. Agreed to establish a **consensus process expert working group** to develop the options further.
Design Phase	
5. Appointment of consensus process expert working group	The **Consensus Process Working Group** was established in February 2023, and included: Andrew Ash (ISP), Kerrie Wilson (IEP) [no longer a member of the Working Group once appointed as Queensland's Chief Scientist in November 2023], and Roger Shaw, Trevor Ward, John Cook and Daniel Druckman, as independent experts, with Contract Managers (from DCCEEW and DESI) providing policy input when needed, and the SCS Coordination Team assisting in the delivery and coordination of the process.
6. Review and input on consensus process by Consensus Process Working Group	The **Consensus Process Working Group** provided input to the design of the 2022 SCS Consensus Process during six online sessions, from February to June 2023.
7. Further refinements made to draft process by SCS Coordination Team	The SCS Coordination Team refined and finalised the process with input from DCCEEW and DESI Contract Managers in early July to ensure the process met end user needs. Final consensus process presented to the ISP in July 2023.

[4] Thomas & Waterhouse (2021) Scientific Consensus Statement Planning Project. Recommendations for the 2022 iteration of the SCS. Report prepared for DESI.

Appendix 2: Scoping of options for the 2022 SCS consensus process

Table A2. Summary of relevant and accepted methods and measures of scientific consensus/agreement.

Method name and reference(s)	Description / Key points	Timeframes and resources required	Overall suitability for the 2022 SCS process
1. Delphi method (online) (Cam et al., 2002; Jones & Hunter, 1995; O'Hagan, 2019; Waggoner et al., 2016)	• Does not require the participants to meet. • It involves two or more rounds of questionnaires and may start with the generation of ideas. • Responses from each round are aggregated and fed back, giving participants the opportunity to revise their answers in light of the responses of the other participants. • The theory behind this method is that the unidentified comments may facilitate interaction between experts and reduce individual bias. • The Delphi method online consists of three components: 1) authorship, 2) interactive polling, and 3) reporting/results. • Three potential ways to define consensus: a predetermined agreement percentage (e.g., 80%), a rating scale of 1 to 5 for each topic, or a majority of participants must rate a topic for inclusion. Software options: -welphi (40 €/month) -Mesydel (quote requested) -eDelphi.org (90 €/3 months) -mostly qualitative Online course on the method ($149, 5h approx.)	It enables a large group of experts to be contacted cheaply, usually by mail, can be self-administered, and there are few geographical limitations. ~1-2 weeks per round of consultation. Usually 3–4 rounds. So up to 1–2 months approx.?	It eliminates the bias and influence that can occur in face-to-face meetings as the respondents remain anonymous. This anonymity allows respondent's opinions to be expressed more freely without any fear of reproach or loss of credibility. However, the anonymity might not encourage open and frank discussions about different views to facilitate reaching consensus. To avoid a compromised decision versus an actual consensus of opinions, multiple rounds ensure thoughtful consideration, and the ranking of each item by the entire response group helps make the ultimate conclusions more reliable than a single meeting.

Method name and reference(s)	Description / Key points	Timeframes and resources required	Overall suitability for the 2022 SCS process
2. Investigate, Discuss, Estimate, Aggregation (IDEA) method (Hanea et al., 2018; Hemming et al., 2018a; 2018b; O'Hagan, 2019)	• The IDEA protocol is a version of the Delphi method. • It only has two rounds with an emphasis on the facilitated discussion between experts after the first round. • Experts are required to investigate questions, clarify meaning and then provide anonymous answers. • The experts receive feedback and are encouraged to discuss the results, resolve different interpretations of the questions, cross-examine reasoning, and evidence and then provide a second and final opinion. • Individual estimates are then combined using a mathematical aggregation.	The IDEA protocol provides a practical, cost effective and repeatable approach to the elicitation of experts and uncertainty using remote technology (e.g. email, Zoom). Timeline: 2 weeks to 4 months for preparation; 2–6 weeks for elicitation (for 20–30 questions max.)	The discussion provides the opportunity to resolve any misunderstandings, promote critical thinking and to share evidence while maintaining anonymity. The advantages of IDEA are the controlled interaction and feedback. The method allows greater interaction compared to the Delphi protocol and is controlled by the facilitator. However, it seems to be designed for questions with probabilistic or quantitative responses. Also, the purpose of discussion in the IDEA protocol is not to reach consensus but to resolve linguistic ambiguity, promote critical thinking and to share evidence.
3. Nominal Group Technique / Expert Panel Method (Jones & Hunter, 1995; Raine et al., 2014; Waggoner et al., 2016)	• Experts (ideally 5–10) independently generate ideas, meet to discuss them, and then privately rank them in order of preference. • The meeting is facilitated either by an expert on the topic or a credible non-expert, and is structured as follows: - Phase 1: Participants write down their views about the topic/question (background literature provided if required). - Phase 2: Participants submit their solutions/ ideas to the facilitator, who shares them with the entire group. - Phase 3: There is a group discussion to clarify and evaluate each idea. - Phase 4: Each of the ideas is ranked by the panel members anonymously on a predetermined scale; those with the highest ranking are kept.	This method is time efficient and is relatively fast because the panel of experts is kept on task and focused throughout the duration of the meeting. However, it can also be expensive and complicated to organise (it requires time, a venue, etc.).	The method can be adapted and be conducted as a single meeting or with the first stage conducted remotely followed by a discussion and rerating at a face-to-face meeting. This method could potentially be used in a combined approach, with one of the other methods (e.g., Delphi method) for the 2022 SCS process (see section 3 for recommendations).

Method name and reference(s)	Description / Key points	Timeframes and resources required	Overall suitability for the 2022 SCS process
	• The cut-off for consensus is predetermined by the researchers running the process.		
4. Consensus development Panels/ Conferences/ Workshops (Garner et al., 2016; Harper, 2019; Rhodes et al., 2020; Waggoner et al., 2016)	• The organising committee selects a panel of representative experts (8–12 members), who are then invited to a face-to-face conference/workshop. • The workshop structure could follow a series of short presentations addressing key questions, followed by small group discussions, to form recommendations and recognise uncertainties. • Large group, roundtable discussions to deliberate further and reach consensus. Alternatively, all collated feedback could be fed back to the small groups to develop consensus responses to each of the questions. • The organising committee writes the report after the meeting and can consult additional external reviewers in subsequent rounds. • The expert panel can comment on the final version, and if consensus is not reached for all points, personal differing opinions could be recorded in an annex.	This method delivers rapid results, as participants are face-to-face in a focused workshop, but it requires resources and excellent organisation (event organising and moderator etc).	Potential introduction of bias due to overly vocal members on the panel. It could be applied to the 2022 SCS, but probably after Lead Authors have proposed Evidence Statements for each question, and an initial list of potential points of consensus for each group/Theme has been agreed by experts. Then, all authors could be gathered in the same place to reach consensus on the final list, with face-to-face discussions (although this would probably limit the number of attendees and the possibility to include international experts in the process).
5. RAND/UCLA Appropriateness Method (RAM) (Fitch et al., 2001; Raine et al., 2014)	• Developed to determine the appropriateness of particular interventions by combining the best available evidence with collective expert judgements. • This method involves sending a literature review and list of possible indications for intervention to participants, who independently rate each item. They then meet to discuss areas of discrepancy, with the aid of a second-round questionnaire showing both their own initial rating and the distribution of all first-round ratings. Following this, they re-rate the items privately and individually.		Similar to methods described above, but specifically designed to rate appropriateness of health care interventions. It combines a first round of independent rating, followed by a second round of rating during a group discussion. Subsequent rounds of (remote) rating might be required. Not directly applicable to the 2022 SCS process.

Method name and reference(s)	Description / Key points	Timeframes and resources required	Overall suitability for the 2022 SCS process
6. 'Red Team-Blue Team' exercise (Levin, 2017)	• Commonly used in defence and cybersecurity. • The process of opposing red and blue teams — the consensus on one side with an equal number of opponents on the other - might work well to encourage new ideas and test the strength of existing ideas, but it is entirely inappropriate for science, as scientific understanding is well established through the scientific method.		This method is not considered appropriate for science, as it gives equal weight to both red and blue teams, despite the scientific evidence on the topic.
7. Focus Groups (Kitzinger, 1995)	• A form of group interview that capitalises on open communication between research participants to generate qualitative data. • People are encouraged to talk to one another: asking questions, exchanging anecdotes and commenting on each other's experience and points of view. • Focus groups discussion of a questionnaire is ideal for testing the phrasing of questions and is also useful in explaining or exploring survey results.		This method would mostly benefit groups of participants with different backgrounds and skills, those reluctant to be interviewed on their own, and people who feel they have nothing to say. The 2022 SCS process can draw on a pool of experts who are willing to participate in the consensus process, hence this method would not be recommended.
8. 'One-Text' or 'Single-Draft Text' Procedure[5][6] (Fisher et al., 2011; Simmons, 2022)	• Effective way to facilitate creative, joint problem-solving whenever there are multiple stakeholders whose input to a decision or plan needs to be considered or whose support may be needed for implementation. • This method places all drafting authority in the hands of a single drafter or drafting team. All other parties are involved in the process only as critics who provide input. In this way, the inefficiencies of working with multiple drafts are avoided.	A minimum of 2–3 rounds of providing comments to the Draft might be required, hence the process could take 2–3 weeks. The process is done (mostly) online, so no	This method would allow to reach convergence among expert groups while drafting the SCS summary and concluding statements efficiently. It could be efficient, relatively quick (2–3 weeks maximum) and doesn't require additional resources or in-person meetings.

[5] https://discourse.ohie.org/uploads/short-url/65erhMwa8F6TaCAJ9wXpPEZsQvd.pdf
[6] https://www.beyondintractability.org/essay/single-text-negotiation

Method name and reference(s)	Description / Key points	Timeframes and resources required	Overall suitability for the 2022 SCS process
	• Parties work together to iterate and improve a single, shared working draft (hence the name, One-Text or Single-Draft). Parties are asked to note how and why the current draft version of the agreement is not acceptable. • The drafting team iterates between soliciting criticism and revising the draft until (1) they feel they can do no better, (2) the benefits of further incremental improvement seem not worth the cost in time and effort, or (3) a hard deadline for making a decision is reached. At this point, for the first and only time, the drafting team presents all parties with a final draft for acceptance.	additional resources are required.	

Appendix 3: Expert Groups for the 2022 SCS Consensus Process

From the literature review during the scoping phase, it was identified that a panel size of 5-11 members was found to be most beneficial across most consensus methods. Following the advice of the Consensus Process Working Group, it was agreed that the *expert groups* should involve 7-9 experts. The experts were predominantly the Lead Authors of the 2022 SCS Questions within each Theme, as well as some Contributors with relevant expertise to ensure full coverage of the breadth of subjects for each Theme.

Themes 1 and 2 – Values, condition and drivers of health of the Great Barrier Reef

Seven experts were included (all Lead Authors of SCS Questions), from two different institutions, James Cook University (JCU) and the Australian Institute of Marine Science (AIMS).

Question	Name	Role in SCS
1.1	Maxine Newlands (JCU)	Lead Author
1.2/1.3/2.1	Len McKenzie (JCU)	Lead Author
1.4	Aaron Davis (JCU)	Lead Author
1.4	Richard Pearson (JCU)	Lead Author
2.2	Katharina Fabricius (AIMS)	Lead Author
2.3	Stephen Lewis (JCU)	Lead Author
2.4	Sven Uthicke (AIMS)	Lead Author

Theme 3 – Sediments and particulate nutrients

Eight experts were included (six Lead Authors and two Contributors), from four different institutions, JCU, Griffith University (GU), University of Canberra (UC)/Independent and CSIRO. Contributors provided additional expertise in sediment distribution and delivery/transport processes (Z. Bainbridge) and wetlands (F. Adame).

Question	Name	Role in SCS
3.1	Stephen Lewis (JCU)	Lead Author
3.1	Zoe Bainbridge (JCU)	Contributor
3.2	Catherine Collier (JCU)	Lead Author
3.2	Fernanda Adame (GU)	Contributor
3.3	Ian Prosser (UC/Independent)	Lead Author
3.4	Scott Wilkinson (CSIRO)	Lead Author
3.5	Rebecca Bartley (CSIRO)	Lead Author
3.6	Andrew Brooks (GU)	Lead Author

Theme 4 – Dissolved nutrients

Ten experts were included (eight Lead Authors and two Contributors), from five different institutions, AIMS, JCU, GU, UC/Consultant and CSIRO, Great Barrier Reef Foundation (GBRF), Alluvium and an independent consultant. An additional contributor provided expertise on the non-agricultural sections of Q4.6 and wetlands (T. Weber). *Participated in the Conclusions consensus process and final review of the Summary document.

Question	Name	Role in SCS
4.1	Barbara Robson (AIMS)	Lead Author
4.2	Guillermo Diaz-Pulido (GU)	Lead Author
4.2	Catalina Reyes (GBRF)*	Contributor
4.3	Ciemon Caballes (JCU)	Lead Author
4.4	Ian Prosser (UC/Independent)	Lead Author

Question	Name	Role in SCS
4.5	Michele Burford (GU)	Lead Author
4.6	Peter Thorburn (CSIRO)	Lead Author
4.6	Tony Weber (Alluvium)	Contributor
4.7, 4.9	Nathan Waltham (JCU)	Lead Author
4.8	Megan Star (Independent)	Lead Author

Themes 5 and 6 – Pesticides and other pollutants

Seven experts were included (four Lead Authors and three Contributors), from five different institutions, AIMS, JCU, UQ, and Macquarie University (MU), Queensland Government's DESI, and an independent consultant. Contributors provided additional expertise in marine and catchment pesticide risk (M. Warne), hydrology (M. Silburn), and economics of water quality management practices (M. Star).

Question	Name	Role in SCS
5.1	Andrew Negri (AIMS)	Lead Author
5.1	Michael Warne (UQ)	Contributor
5.2	Shelley Templeman (JCU)	Lead Author
5.3	Aaron Davis (JCU)	Lead Author
5.3	Mark Silburn (DES)	Contributor
5.3	Megan Star (Independent)	Contributor
6.1	Anthony Chariton (MU)	Lead Author

Themes 7 and 8 – Human dimensions and emerging science

Eight experts were included (six Lead Authors and two Contributors), from three different institutions, UQ, CSIRO, Burnett Mary Regional NRM Group and four independent consultants. Contributors provided additional expertise in social dimensions of urban water management (T. Schultz), and Indigenous knowledge (C. Burns).

Question	Name	Role in SCS
7.1	Anthea Coggan (CSIRO)	Lead Author
7.2	Roy Murray-Prior (Independent)	Lead Author
7.2	Tracy Schultz (UQ)	Contributor
7.3	Tom Espinoza (Burnett Mary Regional Group)	Lead Author
7.3	Conway Burns (Butchulla Aboriginal Corporation)	Contributor
8.1	Iain Gordon (Independent)	Lead Author
8.1	Megan Star (Independent)	Lead Author
8.2	Michelle Devlin (Independent)	Lead Author