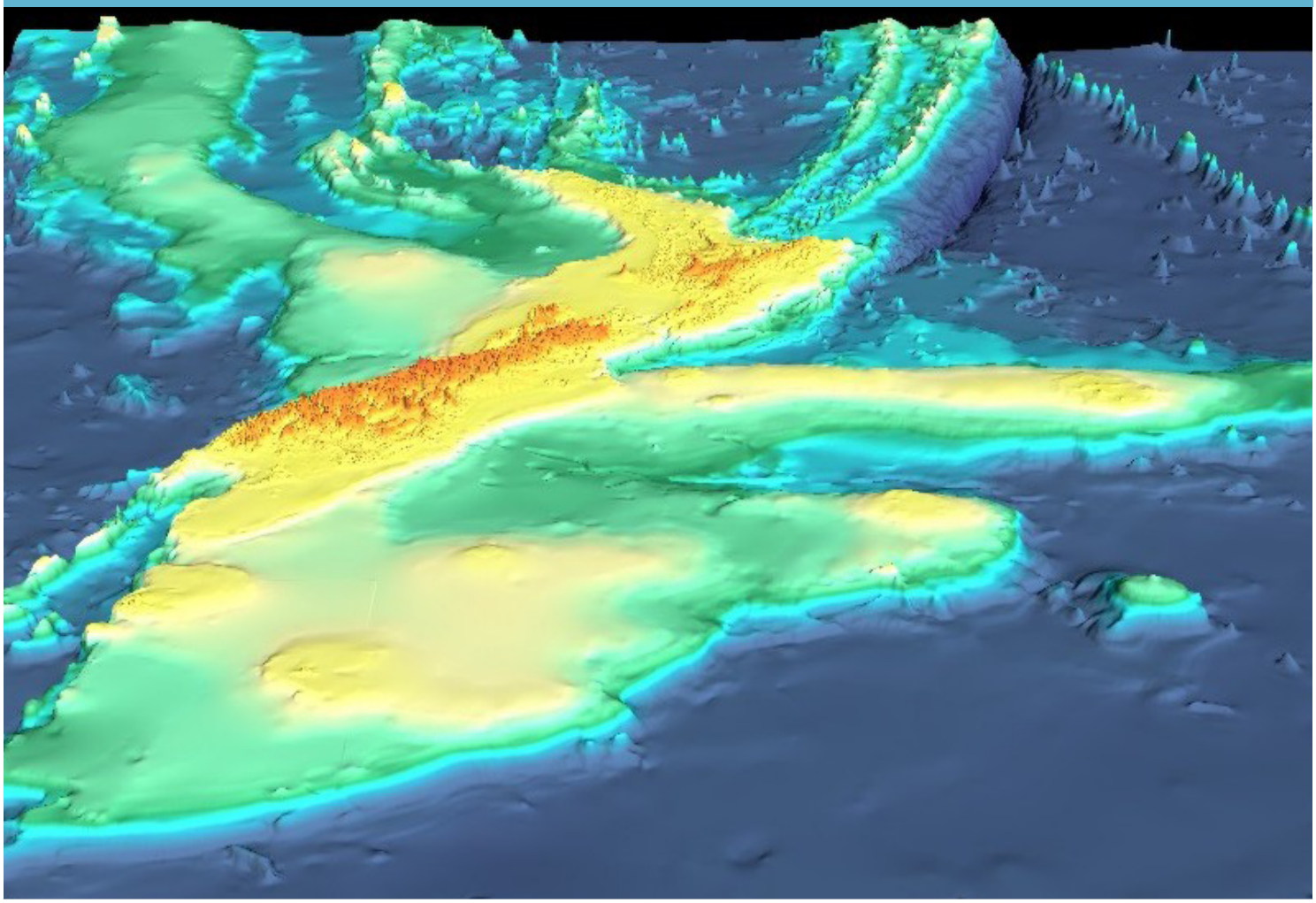
Ministry for Primary Industries
Manatū Ahu Matua

Research and Science Information Standard for New Zealand Fisheries

April 2011



New Zealand Government

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Foreword

The Research and Science Information Standard will make a significant contribution to ensuring that high quality information continues to be used as the basis for New Zealand's fisheries management decisions.

Fisheries contribute substantially to New Zealand's economy and quality of life, annually generating a commercial catch of more than 420,000 tonnes, with export earnings (fisheries and aquaculture) in excess of $1.42 billion. Our fisheries are also of great importance to customary and recreational fishers.

Fisheries 2030 is the Government's goal and plan of action for New Zealand fisheries. It seeks to ensure that fisheries provide the greatest overall economic, social and cultural benefit to all New Zealanders, while ensuring sustainable utilisation of the aquatic environment. Principles underpinning Fisheries 2030 include the use of best available information from a range of sources, and a precautionary approach where information is uncertain. Key to achieving these goals is to ensure that the public can have confidence and trust in the information used to inform fisheries management decisions, the development of environmental standards and the formulation of relevant fisheries policy.

In developing the Standard, international best practices for science quality assurance were reviewed by the Ministry of Fisheries and adapted to New Zealand requirements. Internationally and locally there is an increasing move towards ensuring that high-quality evidence is used for policy formulation and decision-making, with increasing emphasis on the need for independent peer review to ensure the relevance, integrity, objectivity and reliability of information. These key principles for science information quality have been integrated into the Research and Science Information Standard.

I am confident that the result will be a valuable addition to the range of tools available to help ensure that New Zealand fisheries management remains internationally trusted and respected.

Hon Phil Heatley

Minister of Fisheries and Aquaculture

13 April 2011

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1. INTRODUCTION

Purpose of the Standard

The Ministry of Fisheries ("the Ministry") uses *research* and *science information* to underpin fisheries management decisions, the development of environmental standards, and the formulation of relevant fisheries policy.[1] It is important that the Minister of Fisheries and Aquaculture and other decision-makers, and tangata whenua, stakeholders and the public can be confident in the *research* and *science information* used to inform fisheries management decisions.[1] To help achieve this the Ministry needs to:

- Ensure the *quality* and *integrity* of *research* and *science information*, irrespective of the source of that information.
- Require research providers to meet sufficient standards for ensuring the *quality* of *science information*.
- Ensure that *peer review* processes, the primary mechanism for ensuring the *quality* of *science information*, are effective and efficient.

The Standard is a policy statement of best practice in relation to the delivery and *quality* assurance of *research* and *science information* that is intended or likely to inform fisheries management decisions,[1] regardless of the source of that information. It is intended to provide guidance as to what constitutes high *quality* and *reliable science information*, and provides support for implementation of the information principles of Section 10 of the Fisheries Act 1996.

The components and inter-relationships of the Standard are summarised in **Figure 1**. The Standard sets out key principles for *research* and *science information quality* applicable to everyone involved in the provision of *research* and *science information*, responsibilities of different participants, requirements for *peer review* processes, ranking of *science information quality*, storage of data and research reports, and documentation and communication of science results. A summary of the responsibilities of different participants is provided in **Table 1**.

This Standard is consistent with Fisheries 2030 and will contribute to the following actions:

- 2.1 Implementing more efficient models for planning, procurement and delivery of research and observer services.
- 13.3 Improving specification of fisheries services.
- 14.2 Establishing mechanisms to monitor Ministry and sector performance.

The footnotes and the definitions of terms contained in **Appendix A**[2] are an integral part of the Standard.

[1] In subsequent sections of this document, the phrase "fisheries management decisions" is used as shorthand for "fisheries management decisions, the development of environmental standards and the formulation of relevant fisheries policy".

[2] Terms that are defined in **Appendix A** are highlighted in non-bold italics throughout the main text.

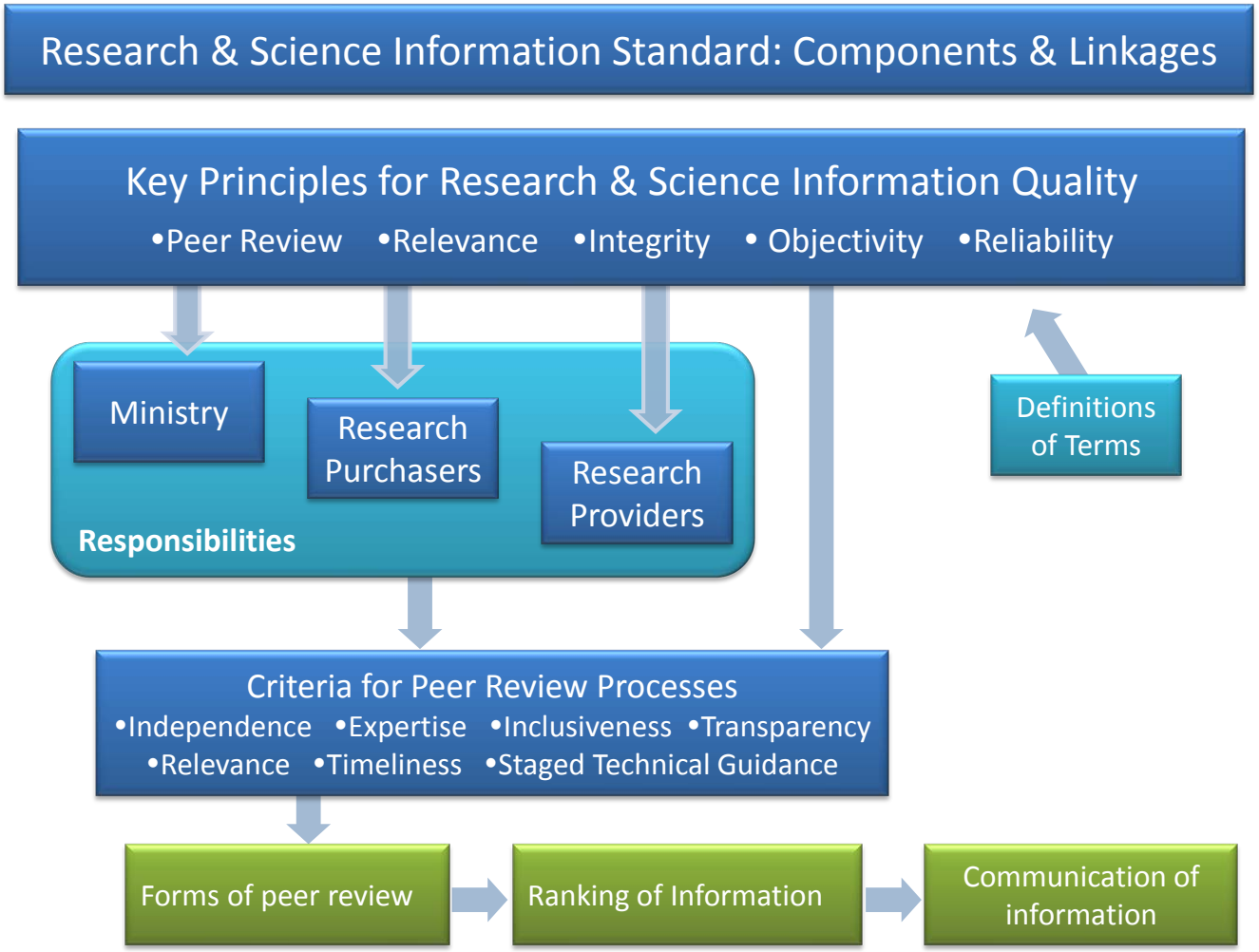

Figure 1. Components of the Research and Science Information Standard and linkages between them.

Table 1. Summary of key responsibilities of the Ministry, research purchasers and research providers.

Responsibilities		
Ministry [3]	**Research Purchasers** [3,4]	**Research Providers** [3]
Establish operational fisheries management objectives to inform the planning and purchasing of *research*		
Evaluate proposed *research* and ensure Ministry-contracted *research* is cost-effective		
Ensure *peer review* processes are established and utilised, including: • determining appropriate forms of *peer review* • appointing Chairs • approving membership and Terms of Reference • ensuring *peer review* criteria are appropriately met	Ensure the *research* design, analyses, results and conclusions are submitted to staged technical guidance and approved *peer review* processes, as appropriate	Submit the *research* design, analyses, results and conclusions to staged technical guidance and approved *peer review* processes, as appropriate
Ensure that research purchasers and research providers comply with all relevant provisions of this Standard	Ensure that research providers comply with all relevant provisions of this Standard	Ensure relevant requirements of this Standard are met, including: • qualifications and capabilities • certification of laboratories and equipment • project management and *quality* assurance processes • *research* is conducted in accordance with relevant technical protocols
Ensure that the *quality* of *research* and *science information* is ranked against the information-ranking provisions of this Standard		
Ensure that all *research* projects are written up in a final research report, at the minimum	Ensure all *research* projects are written up in a final research report, at the minimum	Write up all *research* projects in a final research report, at the minimum
Establish, maintain or support databases to store all relevant data, analyses and research reports	Ensure copies of required data, analyses and reports are made available to the Ministry in an appropriate format	Provide copies of required data, analyses and reports to the purchaser in an appropriate format
Ensure the *integrity* of *research* and *science information* provided to decision-makers	Ensure the *integrity* of *research* and *science information* provided to decision-makers	Ensure the *integrity* of *research* and *science information* provided to decision-makers

[3] Where relevant research is contracted or conducted by other government agencies, such as the Department of Conservation (DOC), the Ministry will work collaboratively with the agency concerned to align research plans and peer review processes. DOC is both a research purchaser and a research provider.

[4] "Research purchasers" include the Ministry.

2. SCOPE AND APPLICATION

Scope

The Standard is intended to apply to *research* and *science information*, particularly information produced by *scientific methods*. *Scientific methods* strive to produce *objective* and *reliable* information, and to document how that information has been derived, such that the results can be *validated* and checked for *reproducibility*.

Scientific methods and *quality* assurance processes can potentially be applied to any *research* project. Much of the *research* and *science information* used to inform fisheries management decisions[1] relates to fisheries characterisations, biological studies, stock assessments, resource abundance surveys and evaluations of fishery impacts on associated or dependent species. However, other disciplines using *scientific methods* also produce information that is used in fisheries management decisions,[1] including broader ecosystem and socio-economic studies. The principles and *quality* assurance processes in this Standard can be applied to any such information.

The provisions of this Standard are intended to apply to:

- *Research* projects contracted by the Ministry.
- *Research* projects conducted or contracted by the seafood industry or other stakeholder organisations as part of agreed *research* programmes.
- Any other *research* independently conducted or contracted, if that *research* is intended or likely to inform fisheries management decisions.[1]

Research planning processes themselves, and processes related to how *research* and *science information* is combined with other sources of information in fisheries management decisions,[1] are not within scope of this Standard.

The Standard is also not intended to apply to subjective information such as anecdotal information, opinions and impressions of individuals, or observations for which there is no *verifiable* evidence beyond their testimony. Such information does not meet the definition of *research* or *science information*. Decision-makers may nonetheless take such information into account, and it may provide important context against which to review the potential impact of alternative fisheries management decisions.[1]

Application

Depending on the extent to which *research* projects fall directly or indirectly under the control of the Ministry, different classes of *research* projects will be subject to the provisions of this Standard in different ways:

i) All *research* projects contracted by the Ministry will be required to comply with the provisions of this Standard. Such requirements will be incorporated into research contracts issued by the Ministry.

ii) For *research* projects not contracted by the Ministry, but which are conducted under agreed *research* programmes, the Ministry will work with research purchasers to ensure the Standard is applied. The research purchaser will be responsible for ensuring that research providers comply with relevant provisions, and that *research* results are submitted for *peer review* as specified by the Ministry. Such review should include staged technical guidance at appropriate phases of the project. The Ministry will ensure that *peer review* requirements are appropriate and cost-effective, taking into account the cost, novelty, complexity and contentiousness of each *research* project.

iii) For *research* projects not covered in the above two categories and that have not been explicitly subject to the requirements of this Standard during the *research* process, the Ministry will determine how to assess their *quality* on a case-by-case basis. Such *research* may include:

- *Research* emanating from other government agencies or other organisations such as regional fisheries management organisations;
- Industry-purchased *research* conducted outside of agreed *research* programmes; or
- Other *research* (including academic studies) not originally intended to inform fisheries management decisions,[1] but which is subsequently considered to be useful for this purpose.

Where information is determined to require further *peer review*, the Ministry will specify and arrange for the necessary *peer review*.

There are several reasons why information under category (iii) above might not be required to undergo further *quality* assurance and *peer review* before being used in fisheries management decisions.[1]

- The information may already have been subjected to adequate *peer review* considered to be compatible with the provisions of this Standard.
- The information may not be particularly influential on the fisheries management decision[1] concerned, or it may be supported by other *reliable* information, such that the time and cost of further *peer review* is not justified.
- The information may emanate from a usually *reliable* source and time constraints may require the information to be used to inform an important fisheries management decision[1] before further *peer review* can be conducted.

Where such information has been subjected to *quality* assurance processes outside of this Standard, the information may receive a Ministry *quality* assurance ranking at the discretion of the Ministry's chief scientific advisor.

The ranking of *research* and *science information* is intended to provide decision-makers, fisheries managers and other interested parties with a clear, standardised and *objective* guide to the assessed *quality* of any piece of information that has been subject to *peer review* under the Standard. However, whether any information constitutes "best available information" under the information principles in Section 10 of the Fisheries Act 1996 is not a determination that will be made under this Standard.

3. CORE ELEMENTS OF THE RESEARCH AND SCIENCE INFORMATION STANDARD

3.1 Key Principles for Science Information Quality

The *quality* of *research* and *science information* relates primarily to *relevance*, *integrity*, *objectivity* and *reliability*. The primary, internationally-accepted mechanism for evaluating the *quality* of *research* and *science information* is *peer review* and, as such, *peer review* is both a principle and a mechanism. These five key principles should underpin all *quality* assurance processes for *research* and *science information*. Ideally, the key principles should be satisfied *PRIOR* to *research* and *science information* being used to inform fisheries management decisions.[1]

***P**eer Review* – Is the principal process used to ensure that the *quality* of *scientific methods*, results and conclusions meet the accepted standards and best practices of the science community. *Peer review* is an organised process that uses peer scientists with appropriate expertise and experience to evaluate the *quality* of *research* and *science information*.

***R**elevance* – Scientific *research* must be *relevant* to the fisheries management question(s)[1] being addressed, contributing directly to answering those management questions and addressing management objectives for that fishery.

***I**ntegrity* – Refers to the security of information, and to the protection of information from inappropriate alteration, selective interpretation or selective presentation. It must be ensured that the information is not compromised or *biased*, particularly with regards to presenting the uncertainty of that information, to ensure that information remains complete throughout the science-to-decision process.

***O**bjectivity* – Refers to whether the information presented is *accurate*, impartial and *unbiased*. *Objective* interpretations or conclusions do not depend upon the personal assumptions, prejudices, viewpoints or values of the person presenting or reviewing the information. *Scientific methods* must be used in the collection and analysis of data, and science processes must be free of undue non-scientific influences and considerations. Data must be obtained from credible and reliable sources. To the extent possible, data and analyses must be *accurate* and *unbiased*.

***R**eliability* – Relates to the *accuracy* and *reproducibility* of information. *Research* and *science information* must be *accurate*, reflecting the true value of the results being reported within an acceptable level of *imprecision* or uncertainty appropriate to the data and analytical methods used. Information should not be *biased* and should not suffer from such a high level of *imprecision* that the results and conclusions are rendered meaningless. Methods and models used to produce *science information* must be *verified* and *validated* to the extent necessary to demonstrate that results may be *reliably reproduced* by an *independent* scientific expert using the same data and analytical methods.

3.2 Responsibilities: Ministry of Fisheries

The Ministry[3] will implement processes and procedures to ensure that the provisions and requirements of this Standard are implemented and adhered to for *research* and *science information* intended or likely to inform fisheries management decisions.[1] Specifically, the Ministry will:

- Establish operational fisheries management objectives, compatible with the requirements of the Harvest Strategy Standard and other relevant or applicable Ministry standards and guidelines, to inform the planning and purchasing of *research*.
- Evaluate project proposals against the requirements for *research* and *science information quality* established by this Standard. This will include evaluation of project design, methodology, scientific expertise and track record, data management procedures, project management capabilities and *research quality* assurance systems of research providers.
- Ensure that Ministry-contracted *research* is cost-effective.
- Ensure appropriate *quality* assurance and *peer review* processes are established, maintained and periodically reviewed.
- Ensure that *research* and *science information* is subjected to effective *peer review* under the provisions of this Standard, and that such *peer review* is appropriate to the cost, novelty, complexity, or contentiousness of that information.
- Appoint Chairs and approve Terms of Reference for *peer review* working groups, workshops, or panels, and ensure that the work of *peer review* processes is brought to a conclusion.
- Ensure that research purchasers[3,4] and research providers[3] comply with all relevant provisions of this Standard.
- Ensure that the *quality* of *research* and *science information* provided to decision-makers is ranked against the information-ranking provisions of this Standard.
- Ensure that all *research* projects are written up to an acceptable standard in a final research report or other format that is acceptable to the Ministry; for example, a Ministry publication series.
- Establish, maintain or support databases to store any required raw data sets and all relevant final data sets, analyses and research reports emanating from relevant *research* projects.
- Ensure the *integrity* of *research* and *science information* provided to decision-makers.

3.3 Responsibilities: Research Purchasers

These responsibilities apply to purchasers of *research* that is intended or likely to inform fisheries management decisions,[1] including the Ministry,[3] the seafood industry and other stakeholder organisations. Research purchasers must ensure that:

- Any research providers they contract to undertake *research* meet the requirements of this Standard. This includes the research providers' credentials and research capabilities, their track record, and their *research* project management and *quality* assurance protocols.
- *Research* projects are designed to answer relevant questions relating to operational fisheries management objectives or policy requirements *objectively* and cost-effectively, and to follow relevant scientific best practices and technical protocols, including those specified in **Appendix B** of this Standard, as periodically updated.
- Full *research* proposals are provided to the Ministry prior to commencement of *research* in order to facilitate early detection of potential problems with the proposed *research* approach, and early evaluation by the Ministry of the *peer review* requirements. This applies to all *research* projects, including those conducted or contracted by the seafood industry or other stakeholder organisations in terms of agreed *research* programmes, and any other *research* independently conducted or contracted. Details of the qualifications and credentials of the research providers involved in the study should be contained in these *research* proposals.
- Both the study design and the conduct of *research* itself remains under the control of appropriately qualified research providers, with input from appropriate *peer review* or staged technical guidance processes.
- The results of *research* projects are submitted for *peer review* appropriate to the cost, novelty, complexity, or contentiousness of that information, as specified or required by the Ministry. Such review should include staged technical guidance at appropriate stages in the project.
- Research providers submit all data, analyses, results, conclusions and reports to *peer review* processes, as specified by the Ministry.
- Research providers are available, when required, to present and explain their *research* results to specified *peer review* processes. They may be requested to conduct additional or revised analyses to correct deficiencies in the treatment of the data, analyses, results, or conclusions, as identified by the *peer review* processes.
- Data generated from *research* projects are made available to the Ministry in appropriate format, in order to facilitate subsequent *verification* of the *reliability* of the results.
- The *integrity* of *research* and *science information* provided to decision-makers is ensured.

3.4 Responsibilities: Research Providers[5]

Research providers providing *research* and science data, analyses, results and reports intended or likely to inform fisheries management decisions[1] must meet requirements for:

- appropriate and adequate qualifications and capabilities;
- project management and quality management;
- data management and provision;
- certification of laboratories and equipment;
- data collection;
- data analysis and synthesis;
- experimental studies;
- technical protocols;
- internal and external *peer review*; and
- research reports.

Qualifications and Capabilities

- *Research* conducted by research providers is to be designed, led and conducted by reputable research staff with appropriate science qualifications, and with respected science publications, in the *research* field(s) concerned.

- Research providers will be expected to demonstrate their capability and track record for delivering high *quality research* and *science information*.

Project Management and Quality Management

- Research providers must demonstrate that they implement and maintain effective in-house project management, *research quality* assurance and data management systems. Research project leaders are to be designated as responsible for project management and *quality* assurance.

- For *research* contracted by the Ministry, or purchased directly by stakeholders, there must be regular monitoring of project progress against project plans to ensure delivery on schedule. Progress reports must be provided as stipulated in the project plan.

[5] Small (1–3 person) research provider organisations may be exempt from some of the requirements detailed in this section. This will be determined by the Ministry on a case-by-case basis.

Data Management and Provision

- Research providers are to establish and routinely follow effective data management and data processing procedures, to ensure the *accuracy* and *integrity* of *research* data. Such systems should include processes for error checking, data *validation* and data-grooming.[6] *Research* data are to be stored in appropriately designed databases, with adequate cataloguing, documentation and metadata. Data backup and disaster recovery systems are to be implemented and maintained.

- All relevant datasets and analyses associated with *research* and *science information* intended or likely to inform fisheries management decisions[1] must be made available to the Ministry for *independent peer review* and possible future *validation* or re-analysis. Where relevant, the computer code developed to analyse data should also be made available. Such data are to be:

  - submitted, when required, in formats appropriate for the respective Ministry databases;
  - appropriately archived to ensure future access;
  - adequately documented; and
  - accompanied by appropriate metadata.

Certification of Laboratories and Equipment

Where *research* will involve laboratory analyses or the use of equipment that requires calibration or operation in accordance with applicable technical protocols, research providers will be required to:

- Demonstrate that laboratories meet any applicable certification requirements.

- Demonstrate that all equipment has been calibrated and certified in accordance with applicable technical protocols for the equipment concerned.

- Maintain the equipment according to manufacturer's instructions or specifications.

Data Collection

- Data must be collected according to documented procedures, and in a manner that reflects standard best practices generally accepted by the relevant science and technical communities. Data and information sources must be identified or made available upon request.

- Data collection methods, systems, instruments and statistical sampling designs must be designed to meet the requirements and objectives of the *research* projects concerned, and should be *validated* before use. Instruments must be calibrated using applicable standards or fundamental engineering and *scientific methods.*

- Data must undergo internal or external *quality* assurance prior to being used in analyses that are intended or likely to inform fisheries management decisions.[1]

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[6] Data grooming is any process whereby data are checked for *accuracy* using objective rules, and data that are known or likely to be incorrect are corrected, deleted or replaced with appropriate estimated values derived from *accurate* data. In many cases data grooming is a data analysis stage rather than a data management process. However, where data grooming procedures become routine, they should be incorporated into established data management processes to avoid duplication of effort.

Data Analysis and Synthesis

- Data analyses must generally be conducted using methods that are documented in published methods manuals or agreed technical protocols (such as those in **Appendix B** to this Standard, as periodically updated), or methods otherwise published and generally accepted by the relevant science and technical communities.
- Routine analytical methods (including statistical procedures, models and other analytical tools) and resulting analyses should be periodically reviewed by suitably qualified internal and/or external experts to ensure their *validity*.
- Analyses that are novel, complex, or contentious must be submitted for appropriate *peer review*, as specified by the Ministry, and reviewed by appropriately qualified *independent* experts.
- Analytical methods must be documented, made available upon request, and included when analyses are disseminated. Details of analytical methods must be included in final research reports.
- The data requirements and assumptions associated with a statistical or analytical model should be commensurate with the resolution and *accuracy* of the available primary data.

Experimental Studies

- The theory and details of experimental designs and methods must be documented. This should include details of assumptions made, any hypotheses established or tested, experimental design, experimental data and results, analytical methods and the statistical procedures employed.
- Novel, complex or contentious experimental studies, including their experimental design, results and analytical methods, must be *peer reviewed* by appropriate *independent* experts. For such experimental studies, results of any initial experimental trials conducted should be made available for staged technical guidance prior to conducting subsequent stages in the study.
- Where it is intended that new experimental methods and approaches should move towards regular or production use, such approaches should first be subjected to thorough and rigorous science *peer review* before being transferred into general *research* use.

Technical Protocols

- Research provider organisations will be required to implement and follow established or adopted technical protocols and established best practices relevant to the *research* field(s) concerned.
- Where tools, techniques, methods or processes represent a significant development, advance, innovation or improvement in the *research* approach used, technical protocols must be drawn up that describe the tools, techniques and processes used when conducting the relevant form of stock, environmental and/or risk assessment. Where such technical protocols already exist, they must be followed.
- **Appendix B** provides references to several Technical Protocols that should be used, where relevant.

Internal and External Peer Review

- Research providers must implement appropriate internal *quality* assurance and *peer review* processes relevant to each of the above requirements, including the production of final research reports.
- Research providers must also submit data, analyses, results, conclusions and reports intended or likely to inform fisheries management decisions[1] to *peer review* processes, as specified by the Ministry, as or when requested to do so. Depending on the cost, size and complexity of the *research* project, this may require submission of project proposals, initial data, interim analyses and results, and final results and conclusions to several stages of technical guidance and *peer review*.

Research Reports

- All *research* projects should be written up at least as final research reports (see Section 3.8). Where the *research* represents a significant advance in the *research* field concerned, research providers are encouraged to write up and submit the results to an appropriate *peer reviewed* science journal.

3.5 Peer Review Processes

Peer review is the accepted and most reliable process for assessment of the *quality* of *research* and *science information*. The use of *peer review* as the principal *quality* assurance method for *research* and *science information* enhances the confidence of the community (including scientists, fisheries managers, tangata whenua, stakeholders and the public) in the findings presented in science reports.

Peer review processes, designed to ensure that *research* and *science information* meets the *science information quality* criteria specified in this Standard, must be established and implemented for all *research* and *science information* that is intended or likely to inform fisheries management decisions.[1]

Peer Review Criteria

Peer review processes must be designed and conducted to meet the criteria described below. The way in which the criteria are met will differ for alternative forms of *peer review*. Trade-offs may be required; for example, between the *independence* of peer reviewers and the inclusiveness of tangata whenua and stakeholder knowledge and viewpoints; or between the need for timely *research* and *science information* and the time required to conduct fully-*independent* expert *peer review* processes.

***Independence* and Expertise –** One of the prerequisites for trust and credibility of *research* and *science information* is that it must be seen as being provided by neutral processes that operate *independently* of politics, financial interests and advocacy.

- *Peer reviews* should be conducted by science experts who:
  - were not responsible for conducting the *research* and analyses under review;
  - have the appropriate expertise and experience to review the *research* and *science information* and analyses concerned; and
  - are able to provide impartial and *objective* review.

- Peer reviewers must primarily be selected on the basis of scientific expertise and experience relevant to the disciplines and subject matter to be reviewed.

- Participants in *peer review* processes are expected to act in an *independent* and expert manner during *peer review* processes. They should not act as direct advocates for any interest group, and are expected to step aside from their sector affiliations and participate as expert individuals primarily interested in producing *objective*, *unbiased* science.

- For *peer review* of *research* projects that are novel, complex, or contentious, a greater degree of *independence* may be necessary to ensure *objectivity* and credibility of the *peer review* process. In such cases, reviewers should not be directly affiliated or associated with affected stakeholder groups, or with the research providers involved in the *research* under review.

- *Peer review* processes should be designed and conducted in ways that are not adversarial, but participants should be prepared to have their contributions challenged in constructive ways.

- Complete *independence* of peer reviewers is unlikely to be achievable within the small New Zealand fisheries and marine science research community. Intentional involvement of interested stakeholders may also be beneficial to increasing trust and acceptance of *research* results. In this case, potential conflicts of interest must be identified and managed during *peer review* processes to ensure that they do not result in *bias* in the information and conclusions.

Balance of Expertise – *Peer review* working groups, workshops, or panels need to incorporate an appropriate range and variety of scientific expertise suitable for review of the information concerned.

- Selection of expert advisers should match the nature of the information under review and the level of technical expertise required, be sufficiently diverse to represent the range of scientific and technical fields of knowledge under review, and be sufficiently balanced to reflect the potential diversity of opinion amongst experts.

- In the context of *peer review* participation, the term 'balance' does not refer to balancing of stakeholder or political interests, but rather to diverse representation of alternative perspectives and intellectual views within the science community.

Inclusiveness – Where relevant and useful to the interpretation and *objective* evaluation of the information under review, tangata whenua, seafood industry and other stakeholder knowledge and experience should also be included in *peer review* processes.

- Provided potential conflicts of interest are identified and managed, the presence of observers at *peer review* meetings can facilitate *transparency* and openness without compromising *objectivity*. Constraints on observers may include not participating in the scientific evaluation of information, analyses and conclusions, or not contributing to the achievement of consensus regarding scientific conclusions.

- The knowledge and expertise of representatives from the different stakeholder or interest groups that is used to inform the scientific debate should be identified as such, and may then be duly reflected in the science advice provided.

***Transparency* and Openness –** Another prerequisite for trust and credibility of *research* and *science information* is that science processes are *transparent* and open to public scrutiny at all stages, particularly during *peer review* and when reporting information.

- There must be a presumption of openness and *transparency* regarding access to final research reports, results and conclusions. Subject to relevant confidentiality requirements or agreements, the public should have access to the final *research* and *science information* products resulting from each stage in their development; from data collection, to analysis and modelling, to reporting of results and conclusions, to subsequent fisheries management decision-making.

- All final *peer-reviewed research* and *science information* underlying fisheries management decisions[1] should be readily accessible to *independent* scrutiny, including by tangata whenua, stakeholders and the public. The *integrity* of *research* and *science information* must be protected when making the information available.

***Relevance* –** *Research* and *science information* should be *relevant* to the fisheries management objectives and associated key questions for the fishery concerned.

- Where information is not considered *relevant* to a fisheries management objective or question, this should be determined and documented by the *peer review* process.

- Information not considered *relevant* to fisheries management objectives or questions should not be used to inform fisheries management decisions[1] related to those questions or objectives.

Timeliness – Practical and efficient fisheries management decisions[1] often require rapid review and provision of *research* and *science information* to fisheries managers.

- Science *quality* assurance processes need to be efficient, and to balance the need to maximise the *quality* of *research* and *science information* with the requirement for cost-effectiveness and timely provision of information, particularly for *research* that follows established and well-tested methodology.

- The need for timeliness of *research* and *science information* can mean that preliminary results of scientific *research* or monitoring programmes may need to be presented before the study is complete. Uncertainties and risks that arise from an incomplete study should be appropriately acknowledged, but not over-emphasised.

Management of Conflicts of Interest – Conflicts of interest arise when a participant's interests could impair, or be perceived to impair, the participant's *objectivity* in *peer review* processes. Actual or potential conflicts of interest must be identified and actively managed so that the impartiality of the *peer review* processes is not called into question.

- Conflicts of interest may include, but are not limited to:
  - personal financial interests and investments;
  - employer affiliations;
  - consulting arrangements;
  - grants or contracts held by, or anticipated by, an individual or research provider; or
  - commercial or personal relationships with others who have material interests in related businesses or stakeholder organisations.
- Peer reviewers should not have conflicts of interest that might seriously constrain their ability to provide impartial, *objective* advice. In particular, Chairs of *peer review* working groups, workshops, or panels must be impartial, and must not have any direct affiliation with research providers whose *research* is being reviewed, or with seafood industry or other stakeholder groups that may be affected by management decisions based on the *research* and *science information* under review.
- While the existence of conflicts of interest need not preclude participation in *peer review* processes, all actual and potential conflicts of interest need to be identified and managed.
- Management of conflicts of interest will primarily be the responsibility of the Chair of the *peer review* working group, workshop, or panel concerned. Chairs of *peer review* processes will be responsible for determining whether any conflicts of interest could jeopardise the *quality* of the science advice, if necessary in consultation with the Ministry's chief scientific advisor. Procedural rules should be established for ensuring conflicts of interest do not jeopardise the *objectivity* of the *peer review* process.
- Terms of Reference for *peer review* processes should include requirements for declaring and managing conflicts of interest that are compatible with the guidelines provided by the Office of the Auditor General (2007). Participants should be required to:
  - declare any actual or potential conflicts of interest;
  - work with the Chair of the *peer review* processes and the Ministry, as appropriate, to manage any actual or potential conflicts of interest; and
  - endeavour to provide their expert advice free from any undue influence by the seafood industry, fisheries managers, stakeholder organisations or other interest groups.

Reporting of Uncertainty and Risk – Presentation of *research* and *science information* must include the evaluation and reporting of uncertainty and risk, where relevant. Research reports should identify and explain known or likely sources of uncertainty, evaluate levels of uncertainty in results, and assess the relevant risks associated with those uncertainties.

- Stock assessments, environmental assessments, risk assessments and other *research* and *science information* products should describe data collection methods, state major assumptions, report sources of uncertainty or statistical error of analytical models, evaluate data limitations, and where appropriate identify studies or analyses that could assist in reducing those uncertainties.

- When quantitative stock, environmental or risk assessments are produced, assessment reports must specify, to the extent practical, the central estimate for the population or ecosystem component affected, as well as appropriate upper and lower confidence intervals.

- Reporting of uncertainty must be *objective* and *unbiased*. Attention must be paid to not over-emphasising or under-emphasising uncertainties in the information or analyses presented. Scientific conclusions must be appropriate to the reported evaluation of uncertainty.

Staged Technical Guidance – The more costly, novel, complex, or contentious *research* and *science information* is considered to be with respect to fisheries management decisions,[1] the more rigorous and *robust* the science *quality* assurance requirements must be. *Research* projects that are novel, complex, or contentious will be subjected to *peer review* at a number of stages through the *research* processes, and may also be subjected to more than one form of *peer review*.

Irrespective of the actual *peer review* process used, early engagement of peer reviewers in the *research* process (e.g. before expensive research surveys are carried out) will enable technical problems to be identified, prevent wastage of resources on invalid or suboptimal methods, and significantly improve the *quality* and *reliability* of results. This is best achieved by staged technical guidance.

Particularly where *research* projects are costly, novel, complex, or contentious, *peer review* and technical guidance should be conducted at the following stages in the *research* process (**Figure 2**):

- Review of the *research* project design to evaluate whether the proposed *research* methods are appropriate, and whether key fisheries management questions[1] will be answered and *research* objectives will be met.

- Evaluation of the *quality*, representativeness and adequacy of data generated by the project, and consideration of the most appropriate analytical methods for those data.

- Review of the analyses, results, conclusions, summary documents and final research reports, including evaluation of the uncertainties of the *research* results and the associated risks for fisheries management.

Forms of Peer Review

There are a number of options for conducting effective *peer review*. The choice depends on factors such as: the need for timeliness; preferences for inclusiveness to facilitate buy-in and mitigate potential end-runs; the cost, novelty, complexity or contentiousness of the *research* and *science information* under review; and other relevant circumstances or requirements.

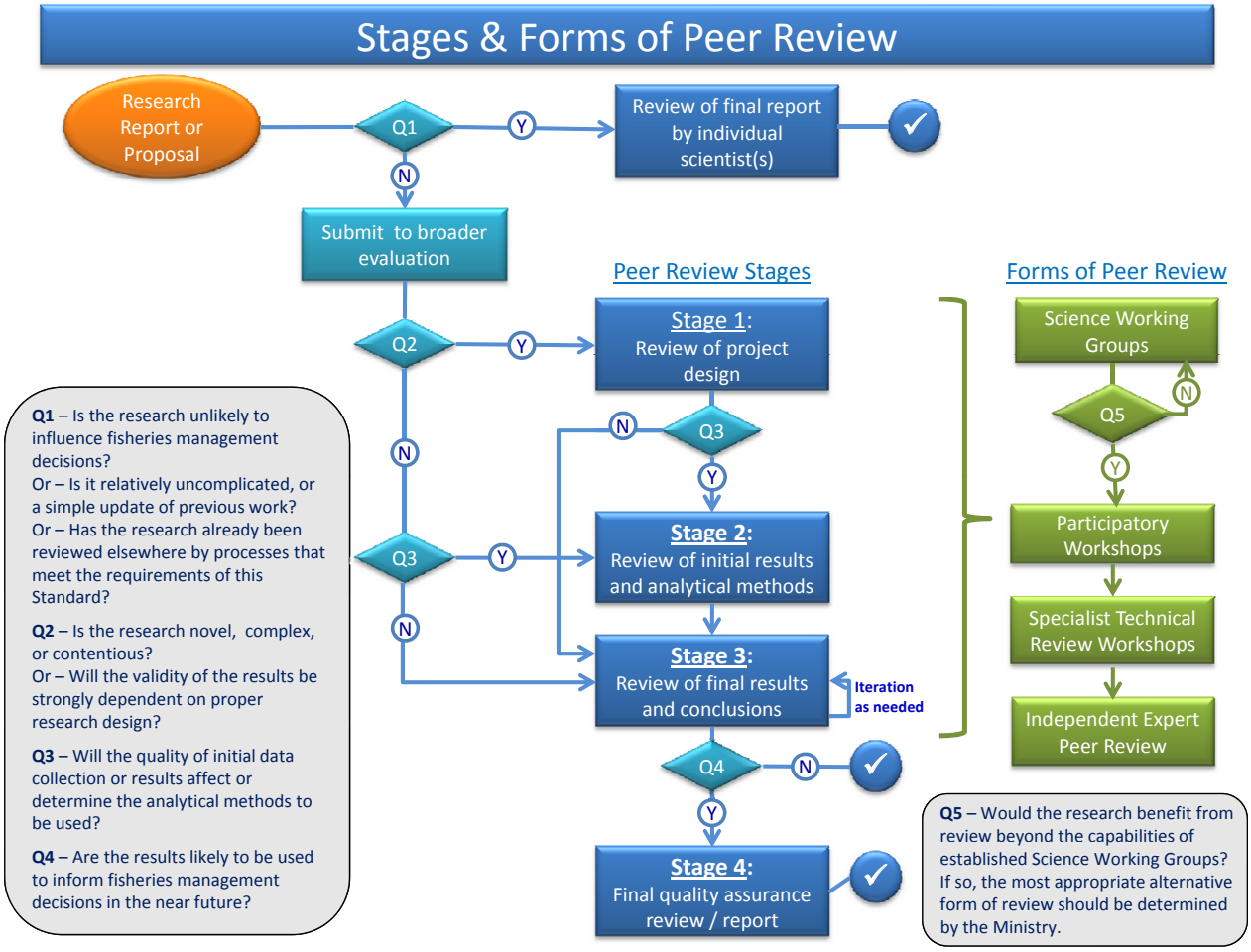

Figure 2. Decision tree showing the stages and forms of *peer review* to which scientific *research* should be submitted.

A variety of *peer review* processes may be undertaken by the Ministry,[3] research purchasers, or research providers. However, the Ministry is responsible for determining the appropriate form of *peer review*, and the membership and terms of reference for the *peer review* working group, workshop, or panel following consultation with relevant parties. The Ministry is also responsible for ensuring the *peer review* criteria are appropriately met at each stage of the *peer review* process.

An overview of the *peer review* process and the alternatives available is shown in **Figure 2** in the form of a decision tree to assist in determining the most appropriate stage and form of *peer review* for individual *research* projects. The Ministry[3] will use this decision tree when determining the appropriate stage and form of *peer review*. Descriptions of the alternative forms of *peer review* are provided below.

Simple *peer review* – if a *research* project is unlikely to influence fisheries management decisions, is relatively uncomplicated or simply an update of previous work, or has already been *peer reviewed* elsewhere by processes that meet the requirements of this Standard, *peer review* of the final research report by one or more qualified scientists may be adequate.

Science Working Groups – where there is a requirement for regular and timely review and provision of science advice, *peer review* can most effectively be conducted by standing science working groups or advisory committees. Science working groups are particularly suitable for review of regular fishery characterisations, updated biological studies, stock assessments, fisheries abundance surveys and regular evaluations of impacts of fisheries. For such *research*, where there is a long history of addressing similar questions, and technical protocols or agreed methods for sound science have already been established and tested, the accumulated experience of members of science working groups can result in highly efficient and reliable review of *research* results.

- Membership of science working groups should tend towards being more inclusive, and should include an adequate range of scientific expertise and stakeholder experience in the range of *research* and *science information* referred to each working group. Such working groups will benefit from the experience of members familiar with the techniques used in the work being reviewed, and from established working relationships where conflicts of interest have been resolved.

- Where agreed technical protocols do not exist for the methodology and analyses under review in a particular working group, but where Ministry or other members of other existing working groups or advisory committees possess expertise, experience and institutional knowledge relevant to the information to be reviewed, *peer review* can still be conducted by science working groups or advisory committees. In such cases, inclusion of additional invited experts will provide broader perspectives and reduce the risk of inadequate *peer review* that might result from limited knowledge or fixed views of existing participants.

Participatory Workshops – where *research* and *science information* and analyses have broad geographic scope, or cover a wide range of disciplines, or are addressing substantial new methodologies or information, or attract considerable interest from diverse stakeholder and public groups, a more diverse and participatory *peer review* workshop process may be required.

- Such participatory workshops can still be led by existing science working group or advisory committee Chairs, but will benefit from being run as one or more broadly participatory meetings with different interest groups. Alternatively, a public meeting or workshop can be used to canvas broad inputs, followed by a specialist technical review workshop or *independent* expert *peer review* panel to collate and critically review the broad inputs.

- Additional experts and suitably experienced tangata whenua and stakeholder group representatives should be included in such participatory workshop processes to ensure that diverse viewpoints and sources of information are fully canvassed and incorporated.

Specialist Technical Review Workshops – are more appropriate where the questions to be addressed, and the information to be reviewed, relate less to providing immediate science advice for fisheries management decisions,[1] and more to reviewing novel, complex, or contentious *research* approaches in order to provide information and technical guidance to future *peer review* processes.

- Specialist technical review workshops should be led by, and should primarily consist of, recognised technical experts in the scientific fields or methodologies being reviewed. Inclusion of additional experts in related fields, and of experienced individuals or tangata whenua or stakeholder representatives, may be beneficial to fully identifying the benefits and shortcomings of alternative technical approaches to particular *research* questions.

- Emphasis in such processes should be on technical expertise, wide canvassing of expert opinion and technical information, consideration of diverse expert perspectives and exploration of new ideas. Such workshops might include review and planning exercises for new data collection or survey methodologies, or technical workshops to reconsider old, and develop new, analytical methods.

***Independent* Expert *Peer Review* –** may be required:

  - where the *research* is novel, complex, or contentious;
  - when there are strong conflicts of interest relating to potential impacts of fisheries management decisions[1] on organisations, industries or groups with whom some participants in regular *peer review* processes are affiliated; or
  - where attempts at *peer review* using existing committees or panels have resulted in adversarial debate and irreconcilable opposing views.

- Fully-*independent ad hoc* expert *peer review* panels should be constituted as and when necessary to provide the highest level of *independent peer review* under situations when one or a combination of the following circumstances applies:

  - questions exceed the technical expertise of the existing science working groups;
  - there is substantial uncertainty and a range of conflicting scientific opinions regarding the interpretation of results;
  - the findings are controversial; or
  - implications for fisheries management decisions[1] are substantial.

- Fully-*independent* expert *peer review* panels should be facilitated and managed by a suitably qualified *independent* expert, with primary responsibility for the review residing with appointed, recognised experts in the *research* field concerned, who are not directly affiliated with anyone involved in, or affected by, consequent fisheries management decisions.[1]

- Ministry, industry-affiliated or other experts may be requested to provide input to the deliberations of an *independent peer review* panel, but the *peer review* report must be produced by the appointed *independent* experts, free from undue non-scientific influences and considerations.

- In some cases, it may be adequate to commission one or more subject matter experts, rather than a panel, to provide *independent peer review*. This is particularly relevant to periodic reviews of *research* programmes and assessment methodologies. *Research* programmes and assessment methodologies should be periodically reviewed to ensure their balance, efficiency and effectiveness in addressing specified management objectives and questions. Establishing the range and priority of questions to be asked, and the balance of *research* projects to address these, is as important as ensuring that individual projects are conducted correctly. Reviews of *research* programmes should be conducted by *independent* science experts who were not involved in the original design or development of those programmes or methodologies.

Appointment and Role of Chairs

Where *peer review* is to be conducted by any form of science working group or advisory committee, participatory workshop, specialist technical review workshop, or *independent* expert *peer review* committee or panel, the role of the Chair is critical to the effectiveness and *objectivity* of the process. The Ministry[3] will determine and formally appoint the Chairs for such working groups, workshops, or panels. Chairs will be carefully chosen to meet the following requirements:

- To be *objective*, impartial and respected scientists in their field, with demonstrated ability, experience and technical knowledge to simultaneously Chair and actively participate in scientific debates on the *research* topics to be dealt with by the *peer review* process concerned.
- To ensure that participants in the review are aware of the Terms of Reference for the review process concerned, and that the Terms of Reference are adhered to by all participants.
- To be responsible for managing conflicts of interest during *peer review* processes.
- To ensure that *peer review* processes are not unduly influenced by the potential fisheries management implications of *research* results or conclusions. Chairs will be required to ensure that fisheries management implications do not jeopardise the *objectivity* of the review or result in *biased* interpretation of results.
- To strive for consensus while ensuring the *transparency* and *integrity* of *research* analyses, results, conclusions and final reports. If consensus cannot be reached as a result of divergent opinions about the interpretation of the *research* results, minority and alternative viewpoints should be recorded.

Peer Review Terms of Reference

Irrespective of the process chosen for *peer reviews*, the scope of work and terms of reference for any *peer review* must be determined in advance of the selection of reviewers. Terms of Reference must:

- Include the mandate, roles and responsibilities of the Chair and participants.
- Identify the *research* projects or issues to be dealt with, including technical questions to guide the *peer review* process.
- Document expectations regarding *peer review* processes and reporting of *peer review* outcomes.

- Allow peer reviewers the opportunity to offer a broad evaluation of the *research* and *science information* under review.
- Ensure that uncertainties and associated risks for fisheries management are clearly identified and appropriately and *objectively* characterised and documented.

3.6 Ranking of Science Information Quality

The Ministry will implement processes to rank the *quality* of *research* and *science information* that is used in support of fisheries management decisions.[1] These ranks are intended to provide a clear and *objective* indication of the *quality* of information used to inform fisheries management decisions.[1] Chairs of *peer review* working groups, workshops and panels will be responsible for ensuring that this is done. Where agreement cannot be reached on the *quality* ranking of a particular piece of *research* or *science information*, the Ministry's chief scientific advisor will be responsible for the final ranking of such information, in consultation with the Chair of the *peer review* working group, workshop, or panel concerned.

Science *quality* assurance and *peer review* processes implemented in accordance with this Standard are required to assess the *quality* of information by applying the following *quality* ranking system:

- **1 – High *Quality*** is accorded to information that has been subjected to rigorous science *quality* assurance and *peer review* processes as required by this Standard, and substantially meets the key principles for *science information quality*. Such information can confidently be accorded a high weight in fisheries management decisions.[1]
- **2 – Medium or Mixed *Quality*** is accorded to information that has been subjected to some level of *peer review* against the requirements of the Standard and has been found to have some shortcomings with regard to the key principles for *science information quality*, but is still useful for informing management decisions. Such information is of moderate or mixed *quality*, and will be accompanied by a report describing its shortcomings.
- **3 – Low *Quality*** is accorded to information that has been subjected to *peer review* against the requirements of the Standard but has substantially failed to meet the key principles for *science information quality*. Such information is of low *quality* and should not be used to inform management decisions.[1] Where it is nevertheless decided to present such low *quality* information in fisheries management decisions,[1] the *quality* shortcomings of the information should be reported and appropriate caution should be applied.
- **Unranked – U** is accorded to information that has not been subjected to any formal *quality* assurance or *peer review* against the requirements of this Standard. Where unranked information is used to inform fisheries management decisions,[1] it should be noted that the information has not been reviewed against the Standard, and that the *quality* of the information has not been ranked and cannot be assured.

Fisheries managers particularly need to be informed when information is unranked (U), or is ranked as being of low *quality*, so that the uncertainties or shortcomings regarding information *quality* can be noted, and appropriate weight given to such information when used to inform fisheries management decisions.[1]

The relationship between internal Ministry processess and *peer review* processes that rank *science information quality* is shown in **Figure 3**.

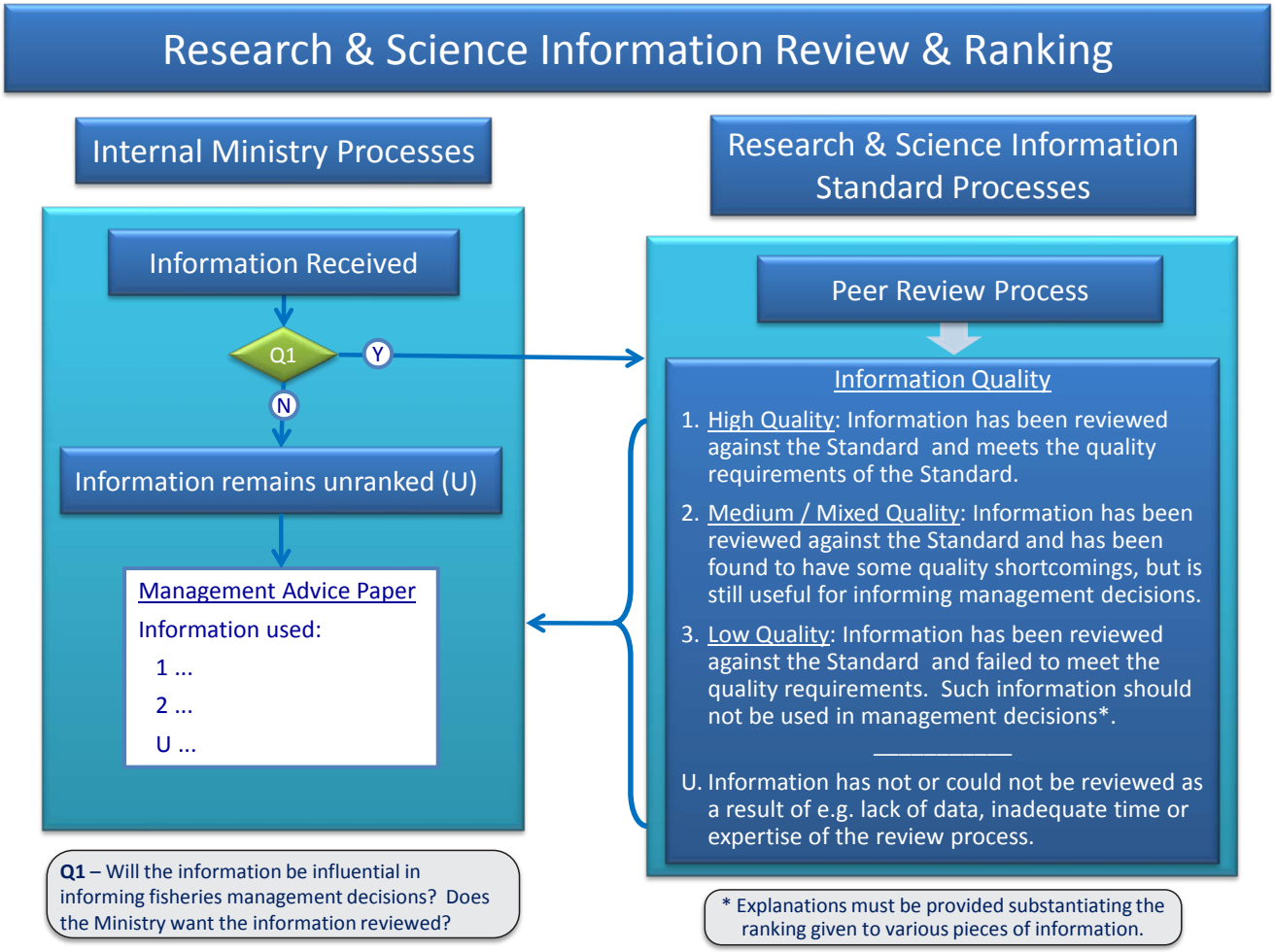

Figure 3. Relationship between internal Ministry processes and *peer review* processes relating to *research* and *science information* review and *quality* ranking under this Standard.

Quality Assurance Sign-off

The final ranking, documentation and communication of *research* and *science information quality* is crucial for translating the complexities of science *quality* assessments to non-scientific audiences. The Ministry's chief scientific advisor will be responsible for final judgement of the *quality* of *research* and *science information* assessed under this Standard, particularly where agreement cannot be reached in *peer review* processes on the quality ranking of a particular aspect of *research* and *science information*. The chief scientific advisor will consult with the Chair of the *peer review* working group, workshop, or panel concerned in order to fulfil this responsibility.

3.7 Data Management

Retention and Storage of Data

The Ministry requires a copy of, or access to, all data and analyses produced as a result of any *research* project that contributes to fisheries management decisions.[1] Access to such information ensures that it can be re-analysed at a future date, allowing for the cumulative process of building on reviews and revisions of knowledge. It also ensures that data analyses can be repeated *independently*, to provide for *validation*, *verification* and evaluation of *reproducibility*, *accuracy* and *objectivity* of the methodology and *research* results.

Where possible, data collected by Ministry-funded *research* will be stored in Ministry databases. If the data do not fit into existing database structures, they will be stored in appropriate format in Ministry archives in a secure and controlled facility, and metadata about the information will be stored on Ministry metadata system(s).

Submission of Datasets

Research providers or research purchasers must provide the Ministry with copies of, or access to, all relevant datasets and analyses emanating from *research* projects that have been subject to review under the provisions of this Standard. Where relevant, this includes computer code used to groom[6] and analyse data.

Ownership of Information and Data

The Ministry will retain ownership of all data and analyses produced as a result of Ministry-funded *research* projects.

For non Ministry-funded projects, the Ministry will not necessarily have ownership of the data but, where possible, will retain and store a copy of all data and analyses that can be accessed, as required, for later re-analysis, subject to relevant confidentiality requirements or agreements. The Ministry will hold these data in a secure and controlled database storage facility. Metadata for the information will be placed in the Ministry's metadata database(s). Where it is not practical for the Ministry to store a copy of data, the Ministry will require clear access and use rights to be set up.

Confidentiality of Information and Data

There will be a presumption of *openness* and *transparency* regarding public access to final *research* analyses and reports that are used to inform fisheries management decisions.[1]

Where considered necessary to protect the commercial sensitivity of certain data (for example, where individual fisher names or vessels are part of a dataset), appropriate confidentiality arrangements and agreements will be developed by the Ministry regarding access to these datasets. Release of these data will be governed by these confidentiality arrangements. Such arrangements will not affect public access to results and reports prepared using these data.

If it has been agreed that certain data are confidential, such data will be marked as "Confidential" in the Ministry metadata database(s). Where commercially sensitive data sets are protected by confidentiality agreements, but access to the data is necessary for the purpose of further analysis, non-sensitive data sets may be prepared upon request, in which the sensitive information is replaced, for example, by anonymous vessel or name keys.

The Official Information Act (1982) – Any data stored by the Ministry may be requested under the Official Information Act. The Ministry has statutory obligations under the Official Information Act and cannot enter into an agreement that this information will not be released. However, the Official Information Act contains provisions to protect information where it is not in the public interest to enforce its release, and specifically provides grounds for withholding commercially confidential information, although this will always need to be balanced against any public interest in releasing the information.

3.8 Documentation and Communication

It is important that the results of *research* are appropriately documented and communicated, including through publication in the primary scientific literature, where appropriate.

Research purchasers and research providers must ensure that all *research* projects are written up in a final research report, at the minimum. Where specified in a project plan, there may be a requirement to instead present the results in a more formalised series,[7] or in the primary scientific literature. For projects involving fishery or environmental assessments, research providers may also be required to write the first draft of relevant sections of a Plenary or Synthesis report.

Once the *quality* of *research* and *science information* has been evaluated, the effective communication of that information to fisheries managers and decision-makers is a critical step in the evidence-based decision process. *Research* and s*cience information* must be documented and communicated fully and completely in clear, unambiguous and understandable language, without detracting from the *quality* and content of that information. The *integrity* of the information must also be protected at all stages.

[7] Currently, the Ministry publishes two formal series, each of which has ISSN numbers (making them readily accessible through libraries and databases that catalogue science publications): Fishery Assessment Reports (FARs), and Aquatic Environment and Biodiversity Reports (AEBRs).

The following steps are required to ensure that *research* and *science information* is clearly documented and communicated:

- Scientists, particularly those who have been responsible for leading or facilitating *peer review* processes, will have primary responsibility for documenting, reporting and communicating the results of *research* projects that have been subjected to *peer review*, including the outcomes of *peer review* processes. This responsibility will include the *accurate* and *objective* reporting of results, uncertainties and associated risks, and the protection of the *integrity* of the *research* and *science information* throughout the communication process.

- Scientists will ensure that *relevant* results emanating from *research* projects are adequately summarised in the appropriate sections of the annual Fisheries Assessment or Aquatic Environment Plenary or Synthesis Reports, together with the conclusions of *quality* assurance and *peer review* of the *research*. These report sections must include appropriate evaluation of uncertainties around the results presented, and assessment of the risks resulting from those uncertainties.

Decision-makers should:

- Ensure that, to the extent possible, *research* and *science information* used for decision-making has been subjected to critical *peer review* processes that meet the requirements of this Standard, and that resulting information meets the requirements for *science information quality* established by this Standard.

- Ensure that a strong communication link is developed and maintained between science advisors and fisheries managers or policy advisors who use *research* and *science information*.

- Require that *research* and *science information* provided to them is complete, *objective* and *accurate*, unfiltered by non-scientific influences or considerations.

- Require that *research* and *science information* be reported to them in clear and unambiguous language, appropriate for subsequent Ministerial and public dissemination.

4. IMPLEMENTATION

The Ministry will develop an implementation plan to ensure that the provisions and requirements of this Standard are:

- Communicated to all those involved in the provision, purchase and evaluation of *research* intended or likely to inform fisheries management decisions.[1]
- Implemented and adhered to by all who are affected by the provisions of the Standard.

Implementation of the Standard will be conducted in stages, as time and resources permit. The initial implementation plan will include specification of:

- Which Ministry staff or roles are to be tasked with each of the responsibilities of the Ministry.
- A requirement to update the Terms of Reference for science working groups to include requirements for identifying and managing conflicts of interest and documenting the outcomes of *peer review* processes.
- Details on how the *science information quality* ranking system will be applied and how and where the results will be recorded.

The initial implementation plan will be refined as science *quality* assurance and *peer review* processes adapt to the requirements of this Standard.

5. BACKGROUND DOCUMENTS AND REFERENCES

Mace, P.M. and A.J. Penney. 2010. Overview of New Zealand's fisheries science peer review processes. 24 pp. Available on request from the Ministry of Fisheries, Wellington, New Zealand.

Ministry of Fisheries. 2008. *Harvest Strategy Standard for New Zealand Fisheries*. 25pp. Available on request from the Ministry of Fisheries, Wellington, New Zealand.

Ministry of Fisheries. 2010. Summary of scientific information quality and peer review processes used by New Zealand Government Agencies, 8 June 2010. 11 pp. Available on request from the Ministry of Fisheries, Wellington, New Zealand.

Ministry of Fisheries. 2010. Report of the Workshop on Scientific Quality Assurance and Peer Review, 10 June 2010. 13 pp. Available on request from the Ministry of Fisheries, Wellington, New Zealand.

Office of the Auditor General, 2007. *Managing conflicts of interest: Guidance for public entities*. Wellington, New Zealand. 53 pp.

Penney, A.J., 2010. Review of International Guidelines for Science Quality Assurance and Peer Review. 82 pp. Available on request from the Ministry of Fisheries, Wellington, New Zealand.

6. APPENDICES

Appendix A: Definition of Terms

For the purposes of interpretation and implementation of this Standard, the following terms are defined to have the following meanings.

Accuracy – the *accuracy* of data or analyses is a measure of the proximity of those data or results to the actual (true) values. As such, *accuracy* is a core component of information *quality*, but one that is impossible to measure directly when the true value is unknown. The processes of science *quality* assurance set out in this Standard provide the means to indirectly assess *accuracy* by checking at each stage of the scientific process for sources of statistical *bias* and *imprecision*, which are key factors that degrade *accuracy*.
Bias – may result from statistical *bias*, personal *bias* or a combination of the two. Statistical *bias* results from non-representative data collection methods or the use of inappropriate analytical methods by which data are reviewed or analysed, interpreted, or published, such that results and conclusions deviate systematically from the truth. Personal *bias* is an inclination or prejudice in favour of a particular viewpoint or conclusion. Both statistical and personal *bias* may contribute to the selective interpretation or presentation of results and uncertainties in a manner that influences subsequent interpretation of the most likely outcome of a scientific analysis.
Independence – as it relates to science *quality* assurance and *peer review* processes, means that the evaluation of the *quality* of *research* and *science information* is conducted by persons who were not involved in producing the information being reviewed, and who do not have conflicts of interest.
Integrity – refers to the security of information, and to the protection of information from inappropriate alteration, selective interpretation or selective presentation. It must be ensured that the information is not compromised or *biased*, particularly with regards to presenting the uncertainty of that information, to ensure that information remains complete throughout the science-to-decision process.
Objectivity – refers to whether the information presented is *accurate*, impartial and *unbiased*. *Objective* interpretations or conclusions do not depend upon the personal assumptions, prejudices, viewpoints or values of the person presenting or reviewing the information. *Objectivity* includes whether the information is presented within a proper context. Sources of information should be provided, in addition to the data and analyses, so that the public can assess for itself whether there may be some reason to question the *accuracy* of the data sources.
Peer Review – is the principle process used to ensure that the *quality* of *scientific methods*, results and conclusions meet the accepted standards and best practices of the science community. *Peer review* is an organised process that uses peer scientists with appropriate expertise and experience to evaluate the *quality* of *research* and *science information*.

Precision – the *precision* of a measurement system is the degree to which repeated measurements under unchanged conditions show the same results. *Precision* does not necessarily imply *accuracy*: a method may be *precise*, but may not be providing an *accurate* (true) measure. Measurements that exhibit an unacceptably high level of *imprecision* are considered *unreliable*.

Quality – in relation to *research* and *science information*, is an encompassing term comprising *peer review, relevance, integrity, objectivity* and *reliability*. By this definition, it is synonymous with *robustness*.

Relevance – refers to the usefulness of the information to its intended users, including government decision-makers, tangata whenua, stakeholders and the public. Scientific *research* must be *relevant* to the fisheries management question(s)[1] being addressed, contributing directly to answering those questions and addressing fisheries management objectives for the fishery of concern.

Reliability – relates to the *accuracy* and *reproducibility* of information. *Research* and *science information* must be *accurate*, reflecting the true value of the results being reported within an acceptable level of *imprecision* or uncertainty appropriate to the data and analytical methods used. Information should not be *biased* and should not suffer from such a high level of *imprecision* that the results and conclusions are rendered meaningless. Methods and models used to produce *science information* must be *verified* and *validated* to the extent necessary to demonstrate that results may be *reliably reproduced* by an *independent* scientific expert using the same data and analytical methods.

Reproducibility - means that the *science information* is capable of being substantially *reproduced*, subject to an acceptable degree of *imprecision* or error, by another expert working *independently* from the expert who originally presented the information. With respect to analyses, 'capable of being substantially *reproduced*' means that *independent* analysis of the supporting data using identical methods would generate similar results, subject to an acceptable degree of *imprecision* or error.

Research – is a process of organised and systematic investigation or inquiry to find answers to specific questions by establishing facts or principles. When *research* is conducted using *scientific methods*, the resulting *research* results can be termed *science information*.

Robustness – *Research* and s*cience information* is judged to be *robust* if it stands up to the challenges of *peer review, relevance, integrity, objectivity and reliability*. By this definition, it is synonymous with *quality*.

Science information – means any knowledge, facts or data that have been generated, tested and *verified* using *scientific methods*. *Science information* includes, but is not limited to, factual input, data, models, analyses, technical information, or scientific assessments, whether conveyed through data compiled directly from surveys or sampling programmes, or through statistical analyses and models that are mathematical representations of reality constructed using primary data. In the context of this Standard, relevant fields of *research* and science include, but are not limited to, biology, ecology, oceanography, economics and sociology.

Scientific method – is a systematic and cumulative process, employing a range of techniques to acquire new knowledge, or to integrate or correct previous knowledge, by gathering observable, empirical and *verifiable* evidence that is used in the formulation and testing of hypotheses. *Scientific methods* must be *objective* to reduce *biased* interpretations of the results, and methodological process steps must be *reproducible*. All data and methodologies must be documented, archived and shared so that they are available for *verification* by other scientists, to confirm the *reproducibility* of results, and to allow statistical measures of the *precision* or *reliability* of these data to be established.

Transparency – a *transparent peer review* process is one that allows the public full and open access to the results of *peer review* working group, workshop or panel meetings, background documents and reports, subject to relevant confidentiality requirements or agreements. *Transparency* also requires the communication to the public in plain language of how decisions were reached, the presentation of policies in open forums, and public access to the findings and advice of scientists as early as possible. The level of expected risk and controversy must guide the nature and extent of *transparency*, with higher levels of risk and controversy demanding a greater degree of *transparency*.

Validation – refers to the testing of analytical methods to ensure they perform as intended. *Validation* should include evaluation of whether:

- the analytical method has been programmed correctly in the computer software;
- the *accuracy* of the estimates is adequate for the intended use;
- the *precision* of the estimates is adequate; and
- the estimates are *robust* to model assumptions.

Verification – is the process of determining that the same results can be obtained from the application of the same methods to the same data. Providing for *verification* requires that the results, data and procedures used to produce the *research* and *science information* are documented in sufficient detail to allow the *reproducibility* of the results to be tested by others, within an acceptable degree of *precision*.

Appendix B: Technical Protocols

Research providers must adhere to accepted technical protocols related to the *quality* of *research* and *science* information that have been developed or endorsed by the Ministry. Where such protocols do not exist, national or international best practice as documented in the scientific literature must be followed.

A partial list of the relevant protocols currently in use in New Zealand is provided below. Several of these may need to be updated and/or formally endorsed.

This list of applicable technical protocols will be regularly updated by the Ministry. Research providers should contact the Ministry to determine the most appropriate technical protocols for the proposed *research*.

Acoustic instrument calibration	Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan and E.J. Simmonds. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Cooperative Research Report 144.* 68 p.
Trawl survey design	Hurst, R.J., N. Bagley, T. Chatterton, S. Hanchet, K. Schofield and M. Vignaux. 1992. Standardisation of hoki/middle depth time series trawl surveys. *MAF Fisheries Greta Point Internal Report No. 194.* 89p. (Report held in NIWA library, Wellington, New Zealand).
	McMillan, P. (Compiler) 1996. Trawl survey design and data analysis procedures for deepwater fisheries research. *NIWA Internal Report (Fisheries) No. 253.* 26 p. (Report held in NIWA library, Wellington, New Zealand).
	Stevenson, M. and S. Hanchet (Compilers) 1999. Design and analysis procedures for inshore trawl surveys. *NIWA Technical Report 53.* ISSN 1174-2631.
Catch sampling programme design	Ministry of Fisheries 2008. Guidelines to the design, implementation and reporting of catch sampling programmes. Science Group, Ministry of Fisheries, July 2008. Available on request from the Ministry of Fisheries, Wellington, New Zealand.
Otolith interpretation and age determination	Tracey, D., P. Horn, P. Marriot, K. Krusic-Golub, C. Green, R. Gili and L. Mieres. 2007. Orange roughy ageing workshop: otolith preparation and interpretation. Report to the Deepwater Fisheries Assessment Working Group. 7–9 February 2007. Wellington, New Zealand.
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ISBN 978-0-478-11927-5 (print)
ISBN 978-0-478-11928-3 (online)

May 2011