Marine Science 2019 v1.2

IA3 high-level annotated sample response

July 2018

Research investigation (20%)

This sample has been compiled by the QCAA to assist and support teachers to match evidence in student responses to the characteristics described in the instrument-specific marking guide (ISMG).

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

2. apply understanding of oceans of the future or managing fisheries to develop research questions
3. analyse research evidence about oceans of the future or managing fisheries
4. interpret research evidence about oceans of the future or managing fisheries
5. investigate phenomena associated with oceans of the future or managing fisheries through research
6. evaluate research processes, claims and conclusions about oceans of the future or managing fisheries
7. communicate understandings and research findings, arguments and conclusions about oceans of the future or managing fisheries.

Note: Objective 1 is not assessed in this instrument.

Queensland Government | Queensland Curriculum & Assessment Authority

For all Queensland schools

181034

Instrument-specific marking guide (ISMG)

Criterion: Research and planning

Assessment objectives

2. apply understanding of oceans of the future or managing fisheries to develop research questions
5. investigate phenomena associated with oceans of the future or managing fisheries through research

The student work has the following characteristics:	Marks
• informed application of understanding of oceans of the future or managing fisheries demonstrated by a considered rationale identifying clear development of the research question from the claim • effective and efficient investigation of phenomena associated with oceans of the future or managing fisheries demonstrated by – a specific and relevant research question – selection of sufficient and relevant sources.	5–6
• adequate application of understanding of oceans of the future or managing fisheries demonstrated by a reasonable rationale that links the research question and the claim • effective investigation of phenomena associated with oceans of the future or managing fisheries demonstrated by – a relevant research question – selection of relevant sources.	3–4
• rudimentary application of understanding of oceans of the future or managing fisheries demonstrated by a vague or irrelevant rationale for the investigation • ineffective investigation of phenomena associated with oceans of the future or managing fisheries demonstrated by – an inappropriate research question – selection of insufficient and irrelevant sources.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Analysis and interpretation

Assessment objectives

3. analyse research evidence about oceans of the future or managing fisheries
4. interpret research evidence about oceans of the future or managing fisheries

The student work has the following characteristics:	Marks
• systematic and effective analysis of qualitative data and/or quantitative data within the sources about oceans of the future or managing fisheries demonstrated by – the identification of sufficient and relevant evidence – thorough identification of relevant trends, patterns or relationships – thorough and appropriate identification of limitations of evidence • insightful interpretation of research evidence about oceans of the future or managing fisheries demonstrated by justified scientific argument/s.	5–6
• effective analysis of qualitative data and/or quantitative data within the sources about oceans of the future or managing fisheries demonstrated by – the identification of relevant evidence – identification of obvious trends, patterns or relationships – basic identification of limitations of evidence • adequate interpretation of research evidence about oceans of the future or managing fisheries demonstrated by reasonable scientific argument/s.	3–4
• rudimentary analysis of qualitative data and/or quantitative data within the sources about oceans of the future or managing fisheries demonstrated by – the identification of insufficient and irrelevant evidence – identification of incorrect or irrelevant trends, patterns or relationships – incorrect or insufficient identification of limitations of evidence • invalid interpretation of research evidence about oceans of the future or managing fisheries demonstrated by inappropriate or irrelevant argument/s.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Conclusion and evaluation

Assessment objectives

4. interpret research evidence about oceans of the future or managing fisheries
6. evaluate research processes, claims and conclusions about oceans of the future or managing fisheries

The student work has the following characteristics:	Marks
• insightful interpretation of research evidence about oceans of the future or managing fisheries demonstrated by justified conclusion/s linked to the research question • critical evaluation of the research processes, claims and conclusions about oceans of the future or managing fisheries demonstrated by – insightful discussion of the quality of evidence – extrapolation of credible findings of the research to the claim – suggested improvements and extensions to the investigation that are considered and relevant to the claim.	5–6
• adequate interpretation of research evidence about oceans of the future or managing fisheries demonstrated by reasonable conclusion/s relevant to the research question • basic evaluation of the research processes, claims and conclusions about oceans of the future or managing fisheries demonstrated by – reasonable description of the quality of evidence – application of relevant findings of the research to the claim – suggested improvements and extensions to the investigation that are relevant to the claim.	3–4
• invalid interpretation of research evidence about oceans of the future or managing fisheries demonstrated by inappropriate or irrelevant conclusion/s • superficial evaluation of the research processes, claims and conclusions about oceans of the future or managing fisheries demonstrated by – cursory or simplistic statements about the quality of evidence – application of insufficient or inappropriate findings of the research to the claim – ineffective or irrelevant suggestions.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Communication

Assessment objective

7. communicate understandings and research findings, arguments and conclusions about oceans of the future or managing fisheries

The student work has the following characteristics:	Marks
• effective communication of understandings and research findings, arguments and conclusions about oceans of the future or managing fisheries demonstrated by – fluent and concise use of scientific language and representations – appropriate use of genre conventions – acknowledgment of sources of information through appropriate use of referencing conventions.	2
• adequate communication of understandings and research findings, arguments and conclusions about the oceans of the future or managing fisheries demonstrated by – competent use of scientific language and representations – use of basic genre conventions – use of basic referencing conventions.	1
• does not satisfy any of the descriptors above.	0

Task

Context
Investigate one of the following claims: • Regional increases in primary ocean productivity may be offset by large, global predicted losses in productivity. • The global ocean conveyor belt can be ‘shut down’. • Aquaculture productivity is essential for achieving food security. • As a model, maximum sustainable yield (MSY) should be used to inform fish stock management. You may identify an alternative claim in consultation with your teacher. This claim must be related to Unit 4 subject matter.
Task
Gather secondary evidence related to a research question in order to evaluate the claim. Develop your research question based on a number of possible claims provided by your teacher. Obtain evidence by researching scientifically credible sources, such as scientific journals, books by well-credentialed scientists, and websites of governments, universities, independent research bodies or science and technology manufacturers. You must adhere to research conventions.

Sample response

Criterion	Marks allocated	Result
Research and planning Assessment objectives 2, 5	6	6
Analysis and interpretation Assessment objectives 3, 4	6	6
Conclusion and evaluation Assessment objectives 4, 6	6	3
Communication Assessment objective 7	2	2
Total	**20**	**17**

The annotations show the match to the instrument-specific marking guide (ISMG) performance-level descriptors.

Key: Research and planning | Analysis and interpretation | Conclusion and evaluation | Communication

Note: Colour shadings show the characteristics evident in the response for each criterion.

Research and planning [5–6] **a considered rationale identifying clear development of the research question from the claim** The rationale shows the process by which the research question has been developed from the claim. **a specific and relevant research question** The response clearly defines the research question so sufficient and relevant data can be collected. The research question is connected to the rationale and the topics covered in the unit.	**Rationale** The Food and Agriculture Organisation (FAO) states that fisheries management 'involves a complex and wide-ranging set of tasks, which collectively have the achievement of sustained optimal benefits from the resources as the underlying goal' (FAO 2016). This statement raises the question what are sustained optimal benefits and how do scientists and governments know when this has been achieved? This lead to further research which found the claim that the setting of quotas by a fisheries management body is based on the concept of maximum sustainable yield (MSY) and this has put a pelagic fishery at risk. The review of this claim would be difficult due to its broad nature. Thus, the question was further refined to consider a pelagic species of economic importance to Australia. Southern Bluefin Tuna (SBT) was chosen as a pelagic species to conduct further research on. Therefore, this essay will consider the following research question: 'Does the set annual total allowable catch (TAC) of Southern Bluefin Tuna (SBT) in Australia effectively sustain the population at 20% of its original monitoring levels?' **Background** Southern Bluefin Tuna are an economically important fish stock that migrate through the Australian Fishing Zone (AFZ) and are managed by The Commission for the Conservation of Southern Bluefin Tuna (CCSBT). This commission was formed as a formalised agreement between signatories to the Convention for the conservation of southern Bluefin tuna. The convention was a response to the significant decline in the number of mature fish in the population and a subsequent decrease in commercial catch totals. Total allowable catch (TAC) is an output control method of

Analysis and interpretation [5–6]

justified scientific argument/s

Scientific arguments are evident throughout the response. The background shows development of the argument by explaining total allowable catch as a form of maximum sustainable yield and linking this to the role of the CCSBT in setting the original 20% target. These arguments are supported with references.

Research and planning [5–6]

selection of sufficient and relevant sources

Sources are related to the topics covered in the unit and are adequate for the development of a scientific argument that responds to the research question.

Analysis and interpretation [5–6]

thorough identification of relevant trends, patterns or relationships

The identified relationships are adequate for the purpose of responding to the research question and can support a valid conclusion. They have direct bearing upon and are applicable to the formation of the scientific argument.

identification of sufficient and relevant evidence

The evidence in the response draws upon the available qualitative and quantitative data to respond to the research question. It links directly to the research question.

fisheries management as it sets a maximum yield target. The TAC is a form of maximum sustainable yield (MSY). The SBT global total allowable catch (TAC) is set to ensure that the SBT spawning stock biomass achieves the interim rebuilding target of 20% of the original spawning stock biomass.

The 20% target set by the CCSBT was set as a means of rebuilding with a 70% probability to the interim target biomass level by 2035 (Commission for the conservation of southern bluefin tuna 2016). In the mid-1980s it became apparent that the SBT stock was at a level where management and conservation was required. There was a need for a mechanism to limit catches. The main nations fishing SBT at the time, Australia, Japan and New Zealand, began to apply strict quotas to their fishing fleets from 1985 as a management and conservation measure to enable the SBT stocks to rebuild.

On 20 May 1994, the then existing voluntary management arrangement between Australia, Japan and New Zealand was formalised when the Convention for the Conservation of Southern Bluefin Tuna, which had been signed by the three countries in May 1993, came into force. The Convention created the Commission for the Conservation of Southern Bluefin Tuna (CCSBT).

In should also be noted that in 1982 the United Nations completed the United Nations Convention on the Law of the Sea (UNCOLS). The UNCOLS established a global framework that aimed to address ocean conservation and protection.

Evidence

The reported global catch of Southern Bluefin Tuna peaked in the late 1950s before declining substantially (Patterson & Stobutzki 2016). The annual global commercial catch has been relatively stable, approximately 16 000Kt (approx. mean between 2006 – 2015, range 6400 Kt), since the mid-2000s (refer to Figure 1)

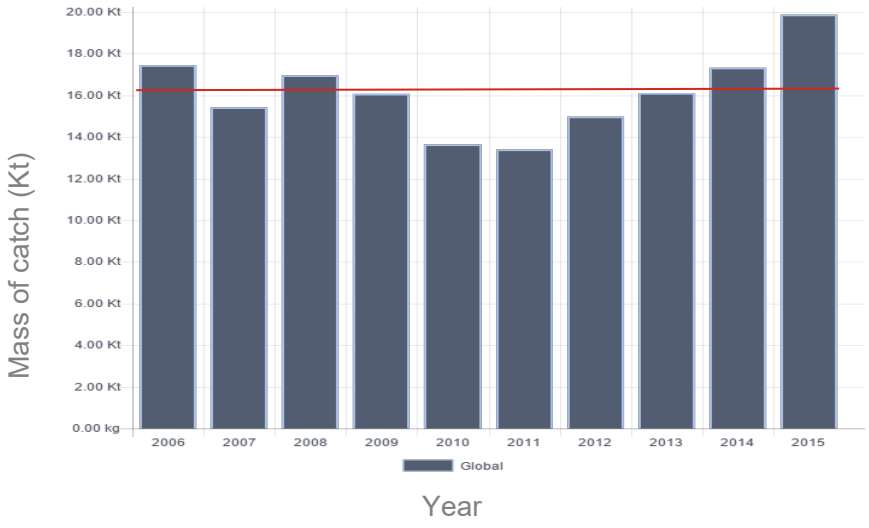

Figure 1: Global commercial catch (Kt) of Southern Bluefin Tuna from 2006 - 2015

(Source: Patterson & Stobutzki 2016)

Analysis and interpretation [5–6]

thorough identification of relevant trends, patterns or relationships

The identified relationships are adequate for the purpose of responding to the research question and can support a valid conclusion. They have direct bearing upon and are applicable to the formation of the scientific argument.

In comparison Australia's southern Bluefin tuna fishery was relatively stable from 1989 to 2009 (Australian Fisheries Management Authority AFMA 2016). Since adopting new management procedures (also called the Bali Procedure) as part of the CCSBT in 2011 Australia's TAC and catch increased in 2015 (refer to Figure 2) (Patterson et al 2016). Figure 2 shows that 2015 had the highest Annual retained catch since 2005.

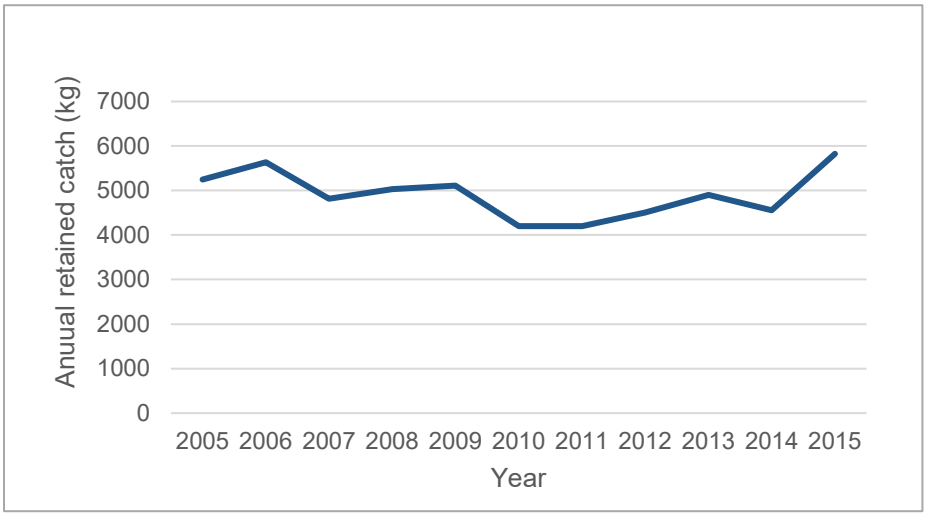

Figure 2: Annual retained catch (kg) of Australian Southern Bluefin Tuna

(Source: Patterson & Stobutzki, 2016)

These CCSBT management procedures (analogous to a harvest strategy) aimed to reduce uncertainty and improve transparency in the decision-making process. That is, the CCSBT identified that 'a procedure should be developed as a set of rules, agreed in advance, to dictate how a Total Allowable Catch for the SBT fishery would be adjusted as data becomes available' (The Organisation for Economic Co-operation and Development, OECD 2012). The aim was to support the recovery target of the biological stock to '20 per cent of unfished biomass by 2035 with 70 per cent probability' (Australian Fisheries Management Authority, AFMA 2016). However, reviews have indicated numerous issues associated with the reliability of the data collected. Firstly, the impact of unreported catches on the estimates of past total catch. Consequently, this lead to the re-evaluation of the initial management procedures. Secondly the carry-forward procedure for member's annual total allowable catch. Members may 'carry forward TAC from the previous year if they have not met quotas' (Extended Commission for the Conservation of Southern Bluefin Tuna, 2014). This makes it difficult to set a sustainable TAC using a specific guideline each year as the carry-forward numbers can impact substantially on the target set. And most importantly, significant over-catch may have occurred in reported data with 'little or no knowledge of the domestic management authority' (OECD, 2012).

Analysis and interpretation [5–6] **thorough identification of relevant trends, patterns or relationships** The identified relationships are adequate for the purpose of responding to the research question and can support a valid conclusion. They have direct bearing upon and are applicable to the formation of the scientific argument.	In addition to this the Southern Blue Tuna spawning stock biomass has declined by 85.4% between 1973 and 2009 (Collette et al 2011). Spawning stock biomass (SSB) measurements are used in fisheries science as a means of stock assessment and fisheries management (Lart, 2017). Spawning stock biomass (SSB) is defined as the total weight of all sexually mature fish in the stock (International Council for the Exploration of the Sea n.d.) and has associated sources of error. The two main methods to approach pelagic stock assessment are cohort analysis and statistical catch-at-age (Dowling 2007). However, the 2011 assessment conducted by CCSBT Extended Scientific Committee reported the estimated biomass of SBT using a proxy based on fish of 10 years an older (B10+). They later revised this in 2014 based on scientific aerial studies of juveniles to incorporate 'relative fecundity, residency time on the spawning grounds and resting times, which vary with age' thus allowing the proxy age to be decreased (B8+) (Patterson *et al* 2016). This resulted in an increase in the estimates of the size of the spawning stock. The current global population trend however is decreasing with no indication from recent stock assessment that the spawning stock is rebuilding (CCSBT 2009). The decline of SSB for SBT classifies this species as critically endangered on the IUCN Red List (Collette *et al* 2011) and based on evidence from AFMA the biological stock is classified as overfished (AFMA 2016). **Evaluation** **Limitations of the data** The strength of reliability of the global data shown in Figure 1 should be considered due to the uncertainty about the models used by each country to collect the data and the significant under-reporting of SBT in past years (OECD 2012). The data shown in Figure 2 is calculated from the date the fish was landed at port and does not include information on catch by gear type. It should be noted that catches can be lower based on management measures such as 'total allowable catch, closing fishing areas, reducing boat numbers or banning the catch of a particular species' and market demand (AFMA 2016) thus affecting the reliability of the data. The potential sources of unaccounted catch mortalities including recreational catches, unreported catch, mortalities of releases, and discarding of fish also needs to be considered with regards to Figure 1 and Figure 2 (Patterson *et al* 2016). **Limitations of data collection** There are key challenges for assessing migratory pelagic fish stocks where the quality of data may be more important than quantity. That is, catch history which correctly identifies the species and standardises the length measurements must be considered to ensure reliability. Length measurements relating to cohort age were based on direct sagittae otolith calculations (Farley & Basson 2005). Given the migratory nature of the SBT spatial issues therefore introduce a significant complexity to the assessment of stock based on these two factors. Southern Bluefin Tuna abundance is generally based on a catch-per-unit-effort (CPUE) but it is difficult to independently survey this. 'Assuming CPUE-based abundance indices, the major challenges are: • ensuring that the spatial/temporal coverage of the fishery is adequate to obtain a reliable abundance estimate, and
Analysis and interpretation [5–6] **thorough and appropriate identification of limitations of evidence** The response identifies limitations of the evidence that are not superficial or partial. The limitations are suitable for determining the reliability of the evidence in responding to the research question.	
Communication [2] **appropriate use of genre conventions** The use of headings and paragraphs fits the purpose of an essay.	

Conclusion and evaluation [1–2]

cursory or simplistic statements about the quality of evidence

The response communicates an oversimplified understanding of the features of the evidence that affect how well it can be used to respond to the research question.

Analysis and interpretation [5–6]

thorough and appropriate identification of limitations of evidence

The response identifies limitations of the evidence that are not superficial or partial. The limitations are suitable for determining the reliability of the evidence in responding to the research question.

Conclusion and evaluation [3–4]

reasonable conclusion/s relevant to the research question

The conclusion is appropriate and is connected to the research question. However, the response does not use evidence to support the conclusion.

application of relevant findings of the research to the claim

The response uses some pertinent outcomes of the research to address the claim. However, the response does not identify the plausible implications of other conclusions.

suggested improvements and extensions to the investigation that are relevant to the claim

The improvements and extensions to the investigation are applicable to the claim but do not show evidence of careful or deliberate thought.

- standardizing the nominal CPUE, as the latter typically is influenced by confounding factors unrelated to abundance.

Statistical CPUE standardisation is typically achieved using generalized linear modelling (GLM) techniques (Dowling 2007).'

There have been fishery-independent aerial surveys conducted in the Great Australian Bight (Eveson *et al* 2007) which therefore do rely on direct sampling techniques. However, these did not continue past the initial trial due to needing two trained observers and a specially trained pilot. This directly impacts on the reliability of the source of SBT data for the Australian region as only one form of data collection technique is being used.

Limitations of data analysis and use of models

In addition to this there are also limitations of using the maximum sustainable yield (MSY) model in conjunction with fisheries in general. The CPUE (catch-per-unit-effort) index was used in the 1950s by Milner Schaefer in conjunction with Verhulst's equation 'which was specifically constructed to deal with numbers of humans or animals' not 'by total weight against an index of the abundance of fish in the population' (Holt 2011) to generate the model of maximum sustainable yield in relation to fisheries management. This became the proposed model for the MSY of tuna stock for management purposes in Schaefer's paper published in 1954 (Holt 2011). Unfortunately, this does not consider the age and size composition of the stock, which is critically important to population stability. Due to the variability and uncertainty in fishing, illegal catches of undersize stock are inevitable. In regulated fisheries, when combined with setting minimum legal sizes and regulating total catch (TAC), the combination has resulted in a global issue of increasingly large quantities of discarded bycatch (Holt 2011).

A confounding problem to the above issues is associated with the limited source of the data (which is referenced in multiple reliable sources). All global data appears to be based solely on the collection from the Commission for the Conservation of Southern Bluefin Tuna which cannot guarantee the reliability of the methods used by each country to estimate their numbers of Southern Bluefin Tuna.

Conclusion

In conclusion, the annual total allowable catch in Australia, set by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), does not effectively sustain the population of Southern Bluefin Tuna at 20% of its original monitoring levels. A model-based MP was undertaken by the CCSBT in 2005 which avoided stock collapse. However due to the limitations outlined in the evaluation section, namely 'underreporting of historical catches' (Kurota *et al* 2010) the implementation of this was aborted. The current scientific advice suggests that Southern Bluefin Tuna stock are at a low level, that is '3–8% of median unfished spawning stock biomass' (CCSBT 2016) and therefore a precautionary approach of closing the fishery should be taken to allow the stock to rebuild.

Further research should include recording the age and size composition of the stock, utilizing fishery-independent aerial surveys (such as the Great Australian Bight trial), and organisations other than the CCSBT producing comparative data.

Communication [2]

fluent and concise use of scientific language and representations

The response is easily understood, avoids unnecessary repetition and meets the required length.

Communication [2]

acknowledgment of sources of information through appropriate use of referencing conventions

The use of a referencing system fits the purpose of an essay.

Word count: 1830

Reference list

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- The Organisation for Economic Co-operation and Development (OECD), 2012, *Rebuilding Fisheries: Southern Bluefin Tuna,* viewed on 18 January 2017, www.oecd.org/tad/fisheries/Southern%20Bluefin%20tuna.pdf.