Australian Government
Department of Agriculture

CCSBT-EC/1910/26
(EC agenda item 4)

Commission for the Conservation of Southern Bluefin Tuna

Progress towards implementation of stereo video

Department of Agriculture

Purpose

At CCSBT25 Australia committed to provide a paper to *CCSBT26 outlining the work it has conducted to automate stereo video measurements, what it has learned through this work and what Australia needs to overcome remaining issues, including what decisions need to be made by the Extended Commission (such as on data standards) in order to resolve these issues to enable implementation of stereo video*.

Background

Average weight estimates of a sample of fish are used to estimate the weight of catch entering tuna farms in Australia. It can be shown that averaging the weight of a sufficient number of fish from the total population will give an accurate average weight of all fish in a farm pen, if the fish are randomly sampled. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT), from 2005 and earlier, has kept under review the forty fish count method Australia used for its southern bluefin tuna (SBT) catch monitoring program for the SBT farm sector. From 2012, Australia increased the forty fish sample to a 100 fish sample from 2012.

Some CCSBT Members have proposed stereo video measurement technology as a means of improving catch reporting accuracy.

In 2010, in response to CCSBT discussions about stereo video technology, Australia agreed to undertake a commercial trial of stereo video to assess its feasibility to improve catch estimates while also meeting industry's operational requirements. Stereo video measurement technology uses an underwater camera system to measure the length of individual fish, either in an aquaculture pen or as fish are transferred from a towing cage. Fish length is then converted to a weight using a regression equation, and an average weight is calculated. The total number of fish is counted and this number is multiplied by the average weight to provide an estimate of the total weight of all the fish in question.

Following the completion of a commercial trial of stereo video in early 2011, the Australian Government, through the Australian Fisheries Management Authority (AFMA), agreed to implement stereo video as the method for determining an average weight in the SBT fishery for the fishing season commencing on 1 December 2013. Australia communicated this decision to CCSBT.

Australian industry noted the inability of stereo video to determine real-time estimates of the total weight being transferred into the farm cage and that this makes it difficult to estimate stocking rates and could lead to overstocking or understocking of farm cages. Industry noted that overstocking farm cages could potentially lead to breaches of regulated stocking limits and posed an increased risk to fish health. Industry also noted that understocking farm cages has potential cost implications through stocking at less economically efficient densities.

Subsequent to the AFMA Commission decision, the Australian Government announced at the Twentieth Meeting of the CCSBT (October 2013) that "*unautomated stereo video monitoring would impose an excessive regulatory and financial burden on industry. The Government had therefore decided to postpone the implementation of stereo video monitoring until an automated solution could be developed although Australia still remains committed to the implementation of stereo video*." It was noted that Australia would be increasing its efforts to find an automated solution as well as continuing with its 100 fish sampling regime.

1 Work conducted to automate stereo video

Australia has continued to closely review developments with stereo video worldwide since 2013.

1.1 Funded research

To investigate potential automated solutions, funding was provided by the Australian Research Council (ARC) and AFMA for a project titled '*Automation of species recognition and size measurement of fish from underwater stereo video imagery*', conducted by Professors Faisal Shafait and Euan Harvey. The project commenced in 2013.

The aim of the project was to develop algorithms to automate the processing of stereo-video images recorded to count and measure the size of fish. The outcomes sought were to improve husbandry and monitoring for finfish aquaculture at reduced costs, create technology export for industry partners and develop cost effective non-destructive finfish sampling tools for marine agencies.

A report from the project *Towards automating underwater measurement of fish length: a comparison of semi-automatic and manual stereo–video measurements* (Shafait et al. 2017) was published in the ICES Journal of Marine Science.

In 2017 Australia facilitated free access to the report for CCSBT Members and provided a copy of the report abstract to CC12 and CCSBT24. In discussion at CC12 Australia noted:

> *While the results were positive, Australia is seeking a fully-automated and cost-effective system that operates in real time without bias. There are still issues to resolve and further work is required, noting improvements in camera and computing technologies since the trial was done. It needs to consult with scientists, AFMA, and consider budgetary implications before deciding on a way to move forward*.

1.2 Engagement with other CCSBT Members

Following Australia's announcement that implementation of stereo video measurement was subject to conditions in 2013, Australia extended an offer to CCSBT Members to observe the 100-fish sampling and transfer process. This offer was accepted by Japan.

At the following meeting of the Extended Scientific Committee (ESC19) Japan presented paper CCSBT-ESC/1409/40 which was a report of the international observation on the 100-fish sampling in Australian SBT farming conducted in February 2014. Japan concluded that although the observation provided a good opportunity to understand the procedure, it was unclear whether the 100-fish sampling provides sufficient representativeness for 10,000–12,000 fish in one tow cage and that the international observation was not enough to resolve the concern over uncertainty in reported SBT catch for the farming sector.

In bilateral discussions with the European Union (EU) in 2014, Australia sought further information about the International Commission for the Conservation of Atlantic Tunas (ICCAT) regulations on stereoscopic cameras and the EU Directive on maritime spatial planning.

DG Mare subsequently provided links to various instruments, which were considered by Australia for their utility in implementing a fully automated and cost-effective stereo video measurement system. Unfortunately none of the systems used under ICCAT regulations were found to meet the conditions required by the Australian Government. Australia appreciated this assistance but was unable to move to implementation of fully automated stereo video measurement based on this information.

In 2019, following up an offer of assistance made by the EU representative to the CCSBT, with respect to the supply of information about the use of stereo video as it is used in ICCAT fisheries in EU fisheries, Australia contacted an expert with knowledge of how stereo video is used. Australia sought information on operational issues such as responsibility for sampling and cost, supply of stereo video equipment, methods for estimating fish numbers in tow cages prior to stereo video measurement, time required to measure fish numbers and length, fish sizes in ICCAT farms and the application of conversion algorithms in tow cages with multi-model distribution. Communication with the EU in this area is ongoing and this information will be important in Australia's progress in implementing stereo video.

Opportunities for the EU to assist Australia with information on the use of stereo video were also discussed during bilateral discussions in January this year. This process is continuing.

1.3 Monitoring of scientific literature

Australia continues to monitor the scientific literature for advances in electronic monitoring and stereo video that may be applicable to SBT fisheries in Australia and that could improve monitoring of catch and bycatch. In addition, Australia regularly consults industry about potential improvements in stereo video technology of which they may be aware.

1.4 Meeting with Australian systems supplier

AQ1 Systems is a world-leading supplier of sensor based feeding control technology for aquaculture. AQ1 Systems is Australia based and provides video-based technology to fish farms worldwide.

In mid-2019, an Australian Government official met with AQ1 Systems for briefing on stereo video measurement technology for fish farms. This meeting confirmed that there is currently no fully automated system available, but recent advances in manual and semi-automated systems appear promising and a fully automated system may be available in the medium term. However specific work to develop a system to meet the particular needs of SBT is likely to be required.

The Australian Government continues to liaise with AQ1 Systems, as well as monitoring other technology providers, with regard to the development of a fully automated and cost effective system. Should a decision be made to proceed with this work, usual Australian Government procurement rules would apply.

1.5 Australian industry activity

The Australian industry has also monitored work on issues related to stereo video systems including those that arise in ICCAT managed systems. Industry notes, however, that none of the systems currently available or in use address the real time or cost-effectiveness issues.

2 What we have learned

Since 2013, Australia has carefully monitored progress with stereo video technology, including automation and cost. Australia has learned over this period that a stereo video system that meets Australia's requirements is still to be developed, but that there have been developments with manual and semi-automated stereo video systems, which may warrant a review of current conditions. This is still under consideration within the Australian Government.

3 What Australia needs to overcome remaining issues

3.1 Policy considerations

In considering Australia's current policy position on the implementation of stereo video, the nature of the conditions on implementation are under regular review. Australia monitors international progress on stereo video technology, particularly with regard to semi-automatic stereo video technology with a view to reviewing the commitment once available technology demonstrably improves and approaches fully automated systems. Australia monitors the requirements of regional fisheries management organisations relating to the measurement of wild caught farm stock as well as actively seeking advice and assistance with stereo video technology in bilateral meetings with relevant countries.

Australia has regular bilateral fisheries discussions with the EU, New Zealand and China and holds ad-hoc bilateral discussions with other countries as opportunities arise. Australia will continue to include discussion on cooperation on stereo video technology in future meetings.

Similarly, Australia is monitoring the development of all stereo video systems with respect to cost. Taking the cost of the 100 fish sample as a reference point, we continue to evaluate the cost of emerging stereo video systems. Australia does not however see complete price parity as a pre-requisite for the implementation of stereo video technology but we would look to ensure that costs were broadly comparable to the 100 fish sample (that is, approximately AUD$540,000 per year).

In considering the implementation of any system requirement, the Australian Government remains mindful of cost and other regulatory burden. The Australian Government is committed to improving the quality of its regulation, including minimising the burden of regulation on businesses, community organisations and individuals. Australia is recognised internationally for its Deregulation Agenda and governance arrangements, particularly its approach to regulatory impact analysis.

3.2 Technical considerations

Based on imagery recorded using an underwater stereo video system during transfers of SBT from tow cages to grow out cages, Shafait et al (2017) identified three limitations of the equipment used in the trial:

1) the camera frame rate is not high enough to capture fast swimming fish;
2) the lighting conditions pose difficulties for low dynamic range of the cameras; and
3) some fish are swimming so strongly that their body deforms from a linear shape as they flex their muscles to drive themselves forwards quickly.

Shafait et al (2017) concluded that the first two limitations can be addressed by using newer, faster, cameras. The last requires better models of the three dimensional deformations of the fish. They concluded that all these issues are tractable and will ensure that semi-automatic SBT surveys will provide improved results and replace manual methods in the future. Australia will

monitor developments in this area, and initiate and fund work related to this, as appropriate and as resources are available.

However, as noted previously, while semi-automated stereo video results are encouraging, the technology required to meet the Australian Government's condition for implementation is not yet available.

4 Way forward

Australia will continue to actively monitor progress in stereo video technology and seek opportunities to support research or trials with a view to implementing our commitment to implementation of stereo video measurement technology as soon as possible.

We note that the methodology used for reporting of farm catch was discussed at the recent meeting of the CCSBT Extended Scientific Committee with the assistance of an expert in this area. Australia looks forward to continuing this discussion at CCSBT26.

References

Shafait, F. Harvey, ES, Shortis, MR, Mian, A, Ravanbakhsh, M, Seager, JW, Culverhouse, PF, Cline, CE & Edgington, DR 2017, Towards automating underwater measurement of fish length: a comparison of semi-automatic and manual stereo–video measurements. *ICES Journal of Marine Sciences*, July – August, vol. 74, no. 6, pp 1690-1701, doi: 10.1093/icesjms/fsx007, accessed 27 September 2019.