



Australian Government
Bureau of Rural Sciences

Tuna farm monitoring Review: Mediterranean, Mexico and Australia

Sands, A and Hender, J.

© Commonwealth of Australia 2007

This work is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced by any process without prior written permission from the Commonwealth. Requests and inquiries concerning reproduction and rights should be addressed to the Commonwealth Copyright Administration, Attorney General's Department, Robert Garran Offices, National Circuit, Barton ACT 2600 or posted at <http://www.ag.gov.au/cca>.

The Australian Government acting through the Bureau of Rural Sciences has exercised due care and skill in the preparation and compilation of the information and data set out in this publication. Notwithstanding, the Bureau of Rural Sciences, its employees and advisers disclaim all liability, including liability for negligence, for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data set out in this publication to the maximum extent permitted by law.

Postal address:

Bureau of Rural Sciences
GPO Box 858
Canberra, ACT 2601

Copies available from:

BRS Publication Sales
GPO Box 858
Canberra ACT 2601

Ph: 1800 020 157

Fax: 02 6272 2330

Email: salesbrs@brs.gov.au

Internet: <http://www.brs.gov.au>

Abstract

At present, all commercial tuna ‘farms’ rely on the capture of wild fish. The inability to directly measure the length and weight of live fish cost-effectively at the time of capture, has created challenges for accurate estimation of the weight of catch. This report compares the range of techniques used to overcome this challenge in tuna farming operations around the world (i.e. Mediterranean, Mexico and Australia).

This report reviews information on the methods used for estimating catch, growth and mortality rates from the relevant Regional Fisheries Management Organisation (RFMO) and other literature. Information derived from interviews with industry participants are used to supplement written information in the public domain. The interviewees were primarily industry members who have participated in commercial tuna farming operations in the Mediterranean and Mexico.

Introduction

The science and management of tuna fisheries are heavily reliant on commercial catch data. The development of commercial tuna farming in the 1990s has introduced an added complexity to data collection for fisheries science and management. At present, all commercial tuna farms rely on captures of wild fish that are fed in captivity for a number of months prior to harvest. The handling of live fish for measuring or tagging can cause stress, physical damage and potentially increase deaths (Pickering 1981, Hampton 1986, Tičina et al. 2004). Direct handling is therefore likely to result in commercial loss and as a result non-invasive techniques are more favourable. The inability to directly measure the length and weight of all farmed fish at the time of capture, without commercial loss, has created difficulties in estimating the actual catch of tuna (Miyake et al. 2003, Tičina et al. 2004). This report compares the range of techniques used to overcome the challenges of data collection in tuna farm fishing operations from around the world.

This report reviews information available from recent Regional Fisheries Management Organisation (RFMO) reports, recommendations, resolutions and scientific literature on tuna farm monitoring practices from the Mediterranean, Mexico and Australia. In particular, the available information on methods used for estimating catch, growth and mortality rates.

Information derived from interviews with industry experts are used to supplement the information in the public domain. The interviewees were primarily industry members who have participated in commercial operations in the Mediterranean and Mexico. For commercial reasons, the majority of the interviews were conducted on a confidential basis.

International Commission for the Conservation of Atlantic Tunas (ICCAT)

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas. ICCAT is responsible for managing the Atlantic bluefin (*Thunnus thynnus thynnus*) farms in the Mediterranean. The ICCAT Secretariat was approached directly via email with a series of questions regarding tuna farm monitoring requirements. No response has been received to date.

There are currently eight countries farming bluefin tuna within the Mediterranean: Croatia, Cyprus, Greece, Italy, Libya, Malta, Spain and Turkey. Current authorised farming facilities are listed on the ICCAT record of bluefin tuna (BFT) farming facilities, which is available online (ICCAT 2007). The majority of countries state they are complying with their ICCAT's resolutions and recommendations by adopting them into their national legislation however there is no detail of how overall catch, mortality rate and growth rate are estimated.

An important source of information was the reports of the General Fisheries Commission for the Mediterranean and the International Commission for the Conservation of Atlantic Tunas (GFCM/ICCAT) Ad hoc working group on sustainable bluefin tuna farming/fattening practices in the Mediterranean. The GFCM/ICCAT working group has conducted a survey on current bluefin tuna farming practices in the Mediterranean. The summary of the survey results included information on how a limited number of farming nations estimate their overall catch as well as bluefin mortality during purse seining and towing. This report, as well as transcripts with interviews of people who have previously spent time in the Mediterranean on tuna farms (Interviewees 1, 3, Tony Jones), provides the majority of information on which this review is based. It is important to note that some information is around two years old although information was superseded by more up to date information where ever possible.

Literature searches on the ICCAT website found one ICCAT resolution and one recommendation directly related to the management of bluefin tuna farming. There are additional general ICCAT bluefin resolutions and recommendations that encompass all bluefin tuna fishing and regulate such things as trade and minimum weight limits. Relevant resolutions and recommendations are located in Attachment 1.

With the exception of Libya and Cyprus, all of the countries involved in bluefin tuna farming have reported that all of the ICCAT conservation and management measures are incorporated into national legislation (ICCAT 2006, ICCAT 2005). Cyprus has stated that they are committed to gradually implementing all ICCAT regulatory recommendations as they only became a contracting party to ICCAT in 2003 (ICCAT 2004). Libya has made no clear pledge in its national report to incorporate all ICCAT resolutions and recommendations into their national legislation (ICCAT 2006).

The sole binding ICCAT resolution directed at bluefin tuna farming, Resolution by ICCAT on Bluefin Tuna Farming [Res. 00-10], required the Standing Committee on Research and Statistics (SCRS) to report the effects of bluefin tuna farming on the collection of catch statistics as well as recommending any possible solutions, if needed, prior to the 2001 meeting and as such, is no longer relevant. The ICCAT recommendation targeted at bluefin tuna farming, Recommendation

by ICCAT on bluefin tuna farming [Rec. 06-07] does regulate tuna farming within the Mediterranean. It recommends that the quantity and number of fish transferred from tow cages to grow out pens is reported. It also requires estimates of growth and mortality during the grow-out process, as well as loss in quantity and number during transportation to grow out pens. The recommendation does not stipulate how these quantities should be measured.

The recommendation also requires size sampling (length or weight) of 10% of the caged tuna (or one sample [100 specimens] for every 100 t of live fish) upon harvest. Each of the Contracting Parties, Cooperating non-Contracting Parties, Entities of Fishing Entities (known as CPCs) are required to nominate a single authority responsible for coordinating the collection and verification of information on caging activities.

The available information on the methods used within the Mediterranean to estimate overall catch of bluefin tuna destined for farming is limited. The most detailed published description of Atlantic bluefin farm catch estimation is found Lovatelli (2005), *'Estimation of the number of fish transferred is usually carried out visually and/or with the aid of accurately positioned underwater video cameras (divers are used) which film the fish moving into the cage. Two separate estimates are provided following slow motion replay of the video one by the fishermen (skipper) and one by the farmers (buyer). An agreed estimate is generally reached following animated negotiations that may last a few days. Size composition is also determined empirically based on experience. The weight of specimens which perished during the fishing operation or transfer exercise coupled with the video recordings also assists in determining the size composition of the catch'*. Individually, Croatia, Malta and Turkey have reported similar methods to those reported above, to estimate their overall catch of bluefin tuna whilst Spain reported using landing reports and logbooks (Leonart & Majkowski 2005). The detail provided by each nation within the GFMC/ICCAT Ad hoc working group survey is summarised in Attachment 2. There was no information available within the public domain as how Cyprus, Greece, Italy or Libya estimates catch or mortality. Details on the methods used to estimate growth rates were not found in publicly available literature and as a result information in this report is based on interviews.

Although there are estimates of mortality during the fishing, towing and/or farming of bluefin tuna for Croatia, Cyprus, Italy, Libya, Malta, Spain and Turkey (Leonart & Majkowski 2005, Lovatelli 2005), there was no available information as to how these estimates were derived, or who derived them. The growth rates of Mediterranean farms are estimated by comparing the estimated weight of fish into farms compared to the harvest weight (Lovatelli 2005). As a result, the accuracy of growth estimates hinge on the accuracy of the capture weight estimates.

Inter-American Tropical Tuna Commission (IATTC)

The Inter-American Tropical Tuna Commission (IATTC) was established in 1950, and is responsible for the conservation and management of fisheries for tunas and other species taken by tuna-fishing vessels in the eastern Pacific Ocean.

There are no resolutions or recommendations regarding bluefin farming within the IATTC and as a result, no requirement for Mexico to include any information on how they estimate their overall catch within their national reports. There are also no quotas for Pacific bluefin tuna and as a result catch estimates are largely for scientific purposes. The International Scientific Committee for Tuna

and Tuna-like Species in the North Pacific Ocean (ISC) and it's the Statistical Working Group (STATWG), has identified the difficulties in determining the actual catch of farmed fish (ISC 2004). They recommended '*that the member countries, that have tuna farming operations, investigate and report on those farming operations; especially on procedures for collection of catch and fish size as fish are placed in pens*' (ISC 2004). If these reports do exist, they were not located within the public domain. Therefore, the only available source of information regarding bluefin tuna farm monitoring practices in Mexico was from Interviewee 3 who had spent a number of years involved with bluefin tuna farm in Mexico. This information is from prior to 2005 as the individual has not been involved in Mexican tuna farms since.

As in the Australian and Mediterranean farms, the number of fish is counted using a video recording of the transfer which is then reviewed later. In Mexico, when weather permits, they are able to record either the transfer from purse seine net to the tow cage or from the tow cage to the farm cage. Like in the Mediterranean, the weights of the fish within the catch are visually estimated within the purse seine nets. Official observers present on board all purse seining vessels (not tow vessels). Mortalities during catching, towing and farming were taken on board and weighed and measured. There was no clear requirement for farms to measure growth rates however the company whom which

Although there are no current IATTC resolutions or recommendations listed on their website, there is still very clear government regulation of tuna farms within Mexico. As the system in Mexico is still mainly paper based, the substantial amount of public information available on tuna farming is not available on the internet.

Commission for the Conservation of Southern Bluefin Tuna (CCSBT)

Australia is the only country within the CCSBT that farm tuna (southern bluefin tuna, *Thunnus maccoyii*). Australian southern bluefin tuna (SBT) farm monitoring practices are well documented within the public domain. For several years, the methods used to estimate catch have been reported in Australia's national report within the CCSBT annual meeting reports. These procedures have also been detailed within the Review of Southern Bluefin Tuna Catch Monitoring Procedures which is available on the Australian Fisheries Management Authority's (AFMA) website.

Tuna farming operations in Australia are monitored by a Government Representative which is contracted annually by AFMA (CCSBT 2006). Currently, there are two methods used to monitor catch (CCSBT 2006). The number of live tuna is counted during the transfer from the tow cage to the farm cage. This count is made using an underwater video recording and is later reviewed by the Government Representative and a farm representative both of whom reach an agreed tally of fish. The number of mortalities since capture is added to this tally to obtain the total number of SBT caught.

The total weight of the tuna catch is estimated via a sample of 40 fish weighing greater than 10kgs from each tow cage (CCSBT 2006). The fish are captured using line or pole with any fish smaller than 10kgs excluded from the weight sample used to calculate an average weight. Fish are measured onboard and are weighed using a spring balance (DSI Consulting PTY LTD 2006). A lack of precision due to the conditions at sea means that weights can only recorded to the nearest

half kilogram. An average of the 40 fish sample is calculated and is multiplied by the total number of fish to obtain an estimate of the total weight of the catch. Growth rates are estimated by comparing the estimated amount of fish entering into the farms versus the overall harvest.

AFMA has been investigating the use of underwater stereo-video technology to measure lengths and body depths during transfer from tow cages to grow-out cages. It has a number of benefits as it is non-invasive and could be used to measure almost the entire catch, as opposed to a 40 fish sample. Stereo-video has also been demonstrated as an accurate and precise tool for measuring biomass of fish contained within cages (Martinez-de Dios *et al.* 2003, Petrell *et al.* 1997, Ruff *et al.* 1995). In particular, it has been used to accurately measure the size of SBT in Australia (Harvey *et al.* 2003), as well as northern bluefin tuna (NBT) (*Thunnus thynnus*) in the Mediterranean (Costa *et al.* 2006). Stereo-video technology is currently being trialled in a commercial setting in the 2006/07 and 2007/08 farming season.

References

- CCSBT (2006) Report of the Thirteenth Annual Meeting of the Commission 10-13 October 2006. Miyazaki, Japan.
- Costa, C., Loy, A., Cataudella, S., Davis, D. and Scardi, M. (2006) Extracting fish size using dual underwater cameras. *Aquacultural Engineering* **35**, 218-227.
- DSI Consulting PTY LTD (2006) Review of Southern Bluefin Tuna Catch Monitoring Procedures. Available from: <http://www.afma.gov.au/fisheries/tuna/sbt/publications/default.htm>
- Hampton, J. (1986) Effects of tagging on the condition of southern bluefin tuna, *Thunnus maccoyii* (Castlenau). *Australian Journal of Marine and Freshwater Research* **37**, 699-705.
- Harvey, E., Cappel, M., Shortis, M., Robson, S., Buchanan, J. and Speare, P. (2003) The accuracy and precision of underwater measurements of length and maximum body depth of southern bluefin tuna (*Thunnus maccoyii*). *Fisheries Research* **63**, 315-326.
- ICCAT. (2007) ICCAT Record of Farming Facilities for Bluefin Tuna (FFB Record). Retrieved March 27 2007, from the World Wide Web: <http://www.iccat.es/ffb.asp>
- ICCAT (2006). Report for Biennial Period, 2004-05, Part II, Volume 3, Annual reports. Spain.
- ICCAT (2005). Report for Biennial Period, 2004-05, Part I, Volume 3, Annual reports. Spain.
- ICCAT (2004). Report for Biennial Period, 2002-03, Part II, Volume 3, Annual reports. Spain.
- ISC (2004). Report of the Statistics Working Group of the 4th Interim Scientific Committee for Tunas and Tuna-like Species in the North Pacific Ocean (ISC). 26 January - 4 February 2004, Honolulu, Hawaii, USA.
- Lovatelli, A. (2005) Summary report on the status of bluefin tuna aquaculture in the Mediterranean. *Report of the third meeting of the Ad Hoc GFCM/ICCAT Working Group on Sustainable Bluefin Tuna Farming/Fattening Practices in the Mediterranean. Rome, 16-18 March 2005.* no. 779, pp. 72-91. FAO fisheries report.

Lleonart, J., & Majkowski, J. (2005) Summary Report on Bluefin Tuna Capture Fishing for Farming/Fattening in the Mediterranean. *Report of the third meeting of the Ad Hoc GFCM/ICCAT Working Group on Sustainable Bluefin Tuna Farming/Fattening Practices in the Mediterranean. Rome, 16-18 March 2005.* no. 779, pp. 65-71. FAO fisheries report

Martinez-de Dios, J.R., Serna, C. and Ollero, A. (2003) Computer vision and robotics techniques in fish farms. *Robotica* **21**, 233-243.

Miyake, P.M., De La Serna, J.M., Natale, A.D., Farrugia, A., Kativic, I., Miyabe, N. and Ticina, V. (2003) General review of bluefin tuna farming in the Mediterranean area. In: Collective volume of scientific papers. International Commission for the Conservation of Atlantic Tunas. Vol. 55, no. 1, pp. 114-124.

Petrell, R.J., Shi, X., Ward, R.K., Naiberg, A. and Savage, C.R. (1997) Determining fish size and swimming speed in cages and tanks using simple video techniques. *Aquacultural Engineering* **16**, 63-84.

Pickering, A.D. (1981) Introduction: The concept of biological stress. In: Pickering, A.D., (Ed.) *Stress and fish*, pp. 1-10. London: Academic Press

Ruff, B.P., Marchant, J.A. and Frost, A.R. (1995) Fish sizing and monitoring using stereo image analysis system applied to fish farming. *Aquacultural Engineering* **14**, 155-173.

Tičina, V., Grubišić, L. and Katavić, I. (2004) Sampling and tagging of live bluefin tuna in growth-out floating cages. *Aquaculture Research* **35**, 307-310.

Attachment 1: A list of important active ICCATT resolutions and recommendations related to farming.

[Res. 00-10] Resolution by ICCAT on Bluefin Tuna Farming.

Requires the Standing Committee on Research and Statistics to report on the effects of tuna farming on the collection of catch statistics and possible solutions for presentation at the 2001 meeting.

[Rec. 06-07] Recommendation by ICCAT on bluefin Tuna Farming

This is the most comprehensive farming recommendation (or resolution) on the collection of data from tuna farms in the Mediterranean. Recommends the reporting of number and quantity of fish transferred into farms. Recommends the provision of estimates of growth, mortality and loss during transportation. It does not stipulate how these estimates should be estimated. It recommends the measurement of 10% (length or weight) at harvest or 100 fish per 100t harvested.

[Rec. 97-04] Recommendation by ICCAT Concerning the Implementation of the ICCAT Bluefin Tuna Statistical Document Program on Re-export.

Details the requirements (such as validation) of ICCAT Bluefin Tuna Re-export Certificates within the ICCAT Bluefin Tuna Statistical Document Program.

[Rec. 02-08] Recommendation by ICCAT Concerning a Multi-year Conservation and Management Plan for Bluefin Tuna in the East Atlantic and Mediterranean.

Recommends that a multi-year conservation and management program be implemented for 2003 to 2006. Details catch limits, closed fishing seasons, minimum size and data collection requirements.

[Rec. 03-16] Recommendation by ICCAT to Adopt Additional Measures Against Illegal, Unreported and Unregulated (IUU) Fishing.

Prohibits landings from fishing vessels, placing in cages for farming and/or the transshipment within their jurisdiction of tunas or tuna-like species caught by IUU fishing activities.

[Rec. 03-19] Recommendation by ICCAT Concerning the Amendment of the Forms of the ICCAT Bluefin/Bigeye/Swordfish Statistical Documents.

Related to the *Recommendation by ICCAT on Bluefin Tuna Farming [03-09]*, the Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities that export farmed bluefin tuna products shall ensure to mark the box "Farmed" in the first line of the ICCAT Bluefin Tuna Statistical Document or the box in item 5 of the ICCAT Bluefin Tuna Re-export Certificate.

[Rec. 04-07] Recommendation by ICATT on bluefin tuna size limit.

Contracting Parties and Co-operating non-Contracting Parties, Entities or Fishing Entities (CPCs) shall take the necessary measures to prohibit the catch, the retaining on board, landing and/or transshipment of any bluefin tuna (*Thunnus thynnus*) weighing less than 10 kg in the Mediterranean Sea.

[Rec. 02-09] Recommendation by ICCAT to develop a plan aimed at reducing the catches of juvenile bluefin tuna in the Mediterranean.

CPC's must develop plans directed at reducing their catches of juvenile bluefin tuna in their Mediterranean fisheries with the objective of reaching at least the tolerance levels indicated in the current ICCAT recommendations for the protection of juvenile bluefin tuna which according to SCRS recommendations, would lead to a reduction of at least 60% in the number of fish caught below 6.4 kg in the Mediterranean.

Attachment 2: Available information on the methods used by individual farming nations to estimate and sample catch. Modified from Leonart & Majkowski 2005.

Farming nation	How the overall catch is estimated (tonnes)	How the catch is sampled (for size composition)
Croatia	Underwater video recording, camera counting during transfer, divers' estimates based on their experience.	No sampling.
Malta	The catch transferred to the grow-out cages is estimated during the transfer at the farm. The documented data (ICCAT stat doc or T2M) are normally based on the weights of bluefin mortalities during capture and transport. The number of individuals in the cage is normally counted by both fishermen and farmers. The numbers are then confirmed and agreed upon at harvest	Sampling size composition (fork length and weight) occurs after grow-out, at harvest.
Spain	Official landing reports from each vessel	Before 2000: On-board observers. After 2000: Observers at fish markets and bluefin processing plants
Turkey	During the transfer from purse seine to the grow-out cage, two divers record the transfer by video cameras. Then, bluefin are counted by the buyer and the skipper (in slow motion) and according to the experience of the skipper and some crew, an average weight is estimated and multiplied by number of the fish	Some bluefin die during purse seining. After weighing the fish and watching the video recordings, a size composition is estimated by the fishermen.