

# IMPROVING POST HARVEST HANDLING TO ADD VALUE TO FARMED MUSSELS

**Report Prepared By**

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# **IMPROVING POST HARVEST HANDLING TO ADD VALUE TO FARMED MUSSELS**

**FRDC Project 2002/418**

**Funded by Seafood Services Australia and Australian mussels farmers**

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## **Disclaimer**

This report has been prepared by the author for Seafood Services Australia.

It is based on primary research and information gathered by the writer from published works and personal interviews.

I believe the report to be accurate but it contains some evaluation of future events and accept no responsibility for the information herein, so readers should make their own enquiries to satisfy themselves on all matters.

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## NON TECHNICAL SUMMARY

The post harvest handling of farmed blue mussels, from the sea farm through to the retail store and restaurant was examined in 2003 in a national study funded by Seafood Services Australia and the Australian mussel farming industry.

**The Objectives** of the study were to: (a) Identify the key quality and marketing parameters for chilled mussels and prepare product specifications for “premium” and “standard” mussels (b) Develop a Code Of Practice which takes account of product labelling, uniform size grading, shell fouling and cleanliness, condition index and any mandatory food safety requirements for the guidance of all industry sectors and (c) prepare a product Trade Users Guide for wholesalers, retailers and restaurateurs.

The project was designed to reduce the volume of poor quality mussels going to market and thereby help raise overall prices for producers and to reduce the wastage experienced by the industry and consumers with poor quality mussels.

Desk research was also carried out to explore the basis of the advice commonly given by cookery writers to discard mussels which do not open after cooking. This warning has led to the waste of many mussels and generated much confusion amongst many trade users and consumers. Cooking tests were undertaken to examine the validity of this advice and to develop a simple method for assessing the “meat content” or Mussel Condition Index.

### OUTCOMES ACHIEVED

Trade interviews clearly indicated that the primary factor driving demand for live mussels is the meat content of the shellfish. Other quality/marketing factors of importance in determining demand and prices were (in descending order): (a) Cleanliness of the shell (b) Size and size grading being true to label and (c) Packaging.

Criteria were established for each of these key factors in developing a product quality specifications table to underpin the Post-Harvest Code of Practice, attached. Three quality grades (basic, regular and premium) and three size grades (cocktail, standard and large) were identified through product research and industry consultation and defined in the product specifications sheet and the size grade table in the Code.

Other noteworthy results, incorporated in the Code, were the industry agreement on overpacking of mussels by at least 5% by weight and the development of a new cheap rapid method for estimating Mussel Condition Index (MCI).

This new method is particularly simple to use and the grower evaluates the mussels just as the chef or consumer does i.e. after cooking. Furthermore by only measuring the cooked meat and shell weight—taking no account of the seawater held inside the two shells of the bivalve — the MCI remains essentially the same when calculated on the harvest day or several days later. The methodology is therefore a substantial improvement on earlier MCI tests.

The term basic is used for product which meets food safety requirements but has a low meat content and little or no sorting regarding quality parameters. The term regular was adopted (in lieu of the word standard) for the common quality grade, which offers

at least 28% meat content. The premium quality grade offers the highest quality: a very clean shell and at least 39% meat content.

A one page leaflet, on water proof paper, to guide trade users such as restaurateurs, retailers and wholesalers on good handling and storage practices and to inform them on the farmers' new developments in size and quality grading was published and made available free of charge. This highlights the need for better temperature control, one of the key factors determining shelf life and consumer satisfaction.

The leaflet was purposely designed as one page for wholesalers and the reverse side for retailers and restaurateurs so that the key points are easily noted when the leaflet is fixed to a cool room wall and serve as a constant reminder of good practices for all personnel. The Code was published with colour illustrations and distributed to all licensed farmers and both the Code and a detailed illustrated version of the Trade Users Guide have been posted on the Seafood Services Australia web site.

The common advice that mussels which do not open after cooking should be thrown out has been found to be based on a long standing fear that the unopen ones were dead before cooking and therefore unsafe to eat. This warning is puzzling given that all or almost all of those unopen ones have experienced more cooking time and heat treatment than those removed from the cooking utensil earlier once they opened—and invariably found to be adequately cooked if opened with a knife.

Mussels are molluscs which live intertidally or under water and close their shells tightly when exposed to unfavourable conditions such as heat or removal from the sea. Our observations had been that with continued exposure to heat, as in cooking, the muscle holding the mussel shells closed weakens and then the shells open up when the muscle breaks off from one of the two shells. Moreover we noted that a very small number of these mussels (average 1.9%) removed early, after they opened up, have not had sufficient heat treatment to cook them adequately and perhaps insufficient cooking to destroy any possible pathogens.

All or almost all dead mussels will have shells open that do not close when tapped. Furthermore any dead mussels which are closed before cooking are just as likely to open up with cooking as the live mussels in the cook batch. Also, live (closed) mussels are just as likely to have pathogens, if present, as are dead closed mussels in any batch.

We concluded that farmed mussels still unopen after cooking are no more dangerous than the open ones and that the traditional warning on unopen mussels is unfounded and has led to a waste of sound mussels. Therefore in the Trade Users Guide leaflet, and in the website version, cooks are advised to carefully examine mussels *before* cooking to detect and avoid cooking dead or doubtful mussels, which are more likely to impart unpleasant flavours rather than make consumers ill.

This R & D project has produced information and publications which can be used by mussel farmers in generic product promotion to stimulate interest and demand for the better grades of mussels and otherwise maximise the benefits from the project. If farmers remain inactive on industry or product promotion then much of the potential benefits of this project will be lost.

## **1. INTRODUCTION**

### **1.1 Background**

The Australian mussel industry has grown only modestly in the past decade because market development and industry income has been constrained by the limited financial resources and the inconsistent approach to product handling and quality management by many farmers.

Some of the farmed mussels grown each year are not harvested and sold because concerned growers with good mussels cannot compete satisfactorily with the cheaper ungraded or poorer quality mussels that are marketed by some growers at times.

The mussel industry had a national meeting in Melbourne in March 2000 — when it was anticipating large increases in output over the next five years— with the support of the Fisheries R & D Corporation, to develop an R & D Strategy and to promote collaboration and communication within the industry. The underlying aim of this meeting was to facilitate a more coordinated, sustainable and profitable growth for the farming industry.

One of the outcomes of this meeting was agreement by farmers to contribute towards the funding of a researcher to develop a national Code of Practice for the post harvest handling of mussels, including the development of product specifications.

It was recognised at this meeting that it would first be necessary to examine the key quality parameters such as size grading so that some consensus could be reached in the selection of product specifications which would be used as the foundation stone for the Post Harvest Code of Practice.

This Code of Practice and a complementary Trade Users Guide were to serve as the primary tools to assist in raising the volume of high quality mussels produced and sold and thereby enhance the aggregate value of farmed mussel production in Australia.

Consultant Nick Ruello was an invited participant at this meeting in Melbourne and was encouraged to prepare a research and development application, as the principal investigator, for submission to the Fisheries R & D Corporation's Seafood Services Australia.

## **1.2 Need For The Project**

There was a number of mussel growers with little knowledge on size grading and grading of mussels in relation to a condition index or “meat content” so that only “good mussels” with a satisfactory quality and shelf life were forwarded to market.

There was a need to identify the key quality and marketing parameters and then develop product specifications for a premium and a “standard” grade mussels as a prerequisite for the development of a Code of Practice on post harvest handling to guide growers, packers and marketers. The Code needed to cover handling, grading, packing, storage and transport of mussels to maximise quality and safety, shelf life and value of the mussel harvest for the benefit of the seafood industry as well as the consumer.

Adoption of the practices recommended in the Code would reduce the amount of poor quality mussels going to market and thereby help raise overall prices for producers and also reduce the wastage experienced by industry and consumers with poor quality mussels.

Wholesalers, retailers and restaurateurs need a users guide with reliable information on how to handle and store mussels to maximise quality and consumer benefit because many of these trade users are experiencing difficulties in maintaining high quality and shelf life of the product they buy.

## **2. OBJECTIVES**

The project objectives were to : (a) Identify the key quality and marketing parameters for chilled mussels and prepare product specifications for “premium” and “standard” mussels.

(b) Develop a Code Of Practice which takes account of product labelling, uniform size grading, shell fouling and cleanliness, condition index and any food safety requirements of government for the guidance of all industry sectors.

(c) Prepare a product Trade Users Guide for wholesalers, retailers and restaurateurs.



### 3 METHODS

The farmers' state representatives participating in the Mussels Meeting in Melbourne 2000 served as an industry reference team to identify the key quality and safety parameters for consideration in this project and provided suggestions for critical limits for each parameter.

The principal investigator visited mussel farmers working in Port Phillip Bay and Port Arthur to gain an up to date picture of how mussels are handled there. He then consulted with other growers in the mussel producing states on regional variations and any particular points or issues of importance to them. Industry meetings were also held at Queenscliff and at Hobart with interested mussel farmers in order to gain maximum input from growers.

Mussel wholesalers, retailers and restaurateurs, 20 in all, were consulted for their input on key parameters, and particular issues of interest to them.

Steam cooking tests were undertaken to develop a simple method for assessing the "meat content" or Mussel Condition Index and to examine how mussels close and then open in cooking to assess the relevancy of the common cookery advice to discard mussels which do not open after cooking.

A draft Code Of Practice was then prepared by the consultant after consideration of the industry input and the requirements of the various state Shellfish Quality Assurance Programs. The first draft was circulated to the mussel association in each state for comment. A draft Trade Users Guide for mussel wholesalers, retailers and restaurateurs was also prepared and then submitted for comment by participating parties.

These draft documents were amended as needed in the light of comment received and resubmitted to the reference group for examination and then endorsement. Simon Bennison (Aquaculture Council Western Australia Executive Officer) and Tony Onley (Queensland Department of Primary Industry Marketing Officer) were also consulted on the layout and extension planning of these documents.

Although not part of the original project plan, desk research was carried out to explore the origins of the advice commonly given by cookery writers to discard mussels which do not open after cooking. This warning has led to the waste of many mussels and generated much confusion amongst many trade users and consumers who have safely consumed these unopen mussels. This advice ignores the natural biological response of mussels to close when they are exposed to harsh conditions (such as cooking temperatures) and focuses consumer attention on mussels after cooking when it is arguably more appropriate to have consumers examine the mussels more carefully before cooking.

Growers were kept informed on progress on the project, and regularly consulted, particularly on the planned arrangements for release of the documents, via email communication and telephone.

The Code and Trade Users Guide leaflet were officially released to the seafood industry and the food media at the Heritage restaurant in Sydney where a presentation on the program, the Code and the Guide were given by the principal investigator. The Code and the Guide were subsequently released in Perth, Port Lincoln, Melbourne and Hobart in November with personal presentations by Mr. Ruello in Perth and in Port Lincoln.

The Code and a more detailed version of the Trade Users Guide were made available to Seafood Service Australia for attachment to its web site.

## 4. RESULTS AND DISCUSSION

### 4.1 Quality Grading, Specifications And The Code Of Practice

Discussion with mussel retailers and restaurateurs indicated that the primary factor driving demand for live mussels is the meat content of the shellfish. Other quality/marketing factors of importance in determining demand and prices were (in descending order):

- Cleanliness of the shell
- Size and size grading being true to label
- Packaging.

All of these factors identified as important to commercial trade in mussels were dealt with at length in developing the product quality specifications (Table 1) for the industry's Post-harvest Code of Practice, which is attached as Appendix 1, and not repeated in detail here.

Other results of note which were incorporated in the Code were the industry agreement on overpacking of mussels by at least 5% by weight (Section 4.2 in the Code) and the development of a new rapid method for estimating Mussel Condition Index (MCI) or meat content.

This new method, entailing the steaming of just 20 mussels, is easy and cheap and the grower evaluates the mussels just as the chef or consumer does ie after cooking. Furthermore by only measuring the cooked meat and shell weight—taking no account of the seawater held inside the two shells of the bivalve—the MCI remains essentially the same when calculated on the harvest day or several days later.

This methodology is a substantial improvement on contemporary industry practices and earlier MCI tests for mussels compared by Davenport J & X Chen in 1987 and is described in full in Section 2.1 of the attached Code.

Three quality grades—basic, regular and premium—and three size grades—cocktail, standard and large—were identified through industry consultation and research and defined in the product specifications sheet and shown below.

| Mussel Size Grades ( based on mussel length) |          |
|--|----------|
| Cocktail                                     | 55-80 mm |
| Standard                                     | 65-80 mm |
| Large  | 80+ mm   |

The term basic describes product which meets food safety requirements, has a low meat content but has had little or no sorting regarding quality parameters. The term regular was adopted (in lieu of the word standard) for the common quality grade, which offers at least 28% meat content. The premium quality grade offers the highest quality: a very clean shell and at least 39% meat content.

The mussel size grades adopted in the Code were adapted from those developed by TASEA, the Tasmanian shellfish marketing company. The Cocktail, Standard and Large size grades herein correspond to TASEA's Cocktail/Standard, Standard and Large respectively.

Growers and consumers will increasingly have the choice of clearly specified sizes and quality grades, subject to seasonal conditions and availability, as well as the traditional ungraded mussels as more and more growers move to producing the higher quality grades of mussels. This will facilitate trade and reduce a lot of the uncertainty that prevails today in the sale and purchase of mussels.

## 4.2 Trade Users Guide

Mussel growers at the Melbourne industry meeting in 2000 identified the need for a simple trade users guide on handling mussels to complement their own Code Of Practice and assist in getting better mussels to consumers.

Research on the distribution of mussels identified that there was a widespread lack of knowledge on good handling practices and particularly the need for temperature control of mussels from farm to retail sale.

A Trade Users Guide was therefore published on an A4 sheet of water proof paper to guide trade users such as restaurateurs, retailers and wholesalers on good handling and storage practices and to inform them on the farmers' new developments in size and quality grading.

The leaflet was purposely designed as one page for wholesalers and the reverse side for retailers and restaurateurs so that the key points on temperature control are easily noted when the leaflet is fixed to a cool room wall or hung from the ceiling. This is made easy by the two holes punched at its head. When attached to a cool room wall or ceiling it can serve as a constant reminder on good practices for all personnel.

This leaflet questions the common advice about discarding mussels which do not open after cooking and emphasises a need to check and wash mussels before cooking—to remove any dead or doubtful mussels—as well as the traditional check of mussels after cooking. This subject and our recommendations are all discussed at length in the following pages.

The leaflet has been distributed free of charge by farmers and various government and industry stakeholders to seafood wholesalers, retailers and restaurateurs. It is attached here as Appendix 2.

A detailed version of the Guide leaflet, complete with the industry's quality specifications table and various illustrations, has been made available on the Seafood Services Australia website [www.seafoodservices.com.au](http://www.seafoodservices.com.au) for those trade users wanting more information. It is attached here as Appendix 3. The farmers Code Of Practice is also available on the SSA website free of charge.

### 4.3 Discarding Of Unopened Mussels

The principal investigator had been cooking mussels and noting the opening/non opening of cooked mussels several years before the commencement of this R& D project but took the opportunity to investigate steam cooking (the common cooking practice) and the history of this widespread advice to discard unopen mussels. This warning is puzzling given that mussels are molluscs which live intertidally or under water and close their shells tightly when exposed to unfavourable conditions such as heat or removal from the sea.

Our observations on cooking had been that live mussels at first close the two shells and then with continued exposure to heat in cooking, the adductor muscle holding the mussel shells closed detaches from one of the two shells, in most cases. But some mussels in almost all batches cooked remained closed, some even after excessive cooking.

Our observations and quantitative data are summarised here but detailed data are in Appendix 4. We noted unopen mussels on 90% of occasions, with cook batch size ranging from 20 to 111 mussels, with an average of 11.5% unopen; the maximum observed was 53% unopen in a cook batch of 66 mussels (Table 1, Appendix 4). We invariably found the unopen mussels to be adequately cooked when opened with a knife—a total of 76 such unopen mussels from five cooking batches were all found to be adequately cooked (Table 2, Appendix 4).

Table 1 shows considerable variation in the percentage of mussels which do not open but a rigorous study of the importance of the various factors determining this, such as harvesting and post harvest handling history, were beyond the scope of this study.

In other tests when unopen mussels were given an extra cook time of 90 seconds, which would then render them as overcooked by cookery writers, as many as 13.2%% still remained closed (Table 3, Appendix 4).

The typical recipe advice is to remove mussels once they open up with cooking with an implication that the mussels that do not open are somehow unsafe to eat. Yet all or most of those that do not open have experienced more cooking time and heat treatment than those removed from the cooking utensil earlier once they opened.

A very small number of the mussels removed early, opening up after only a minute steaming time, had not had sufficient heat treatment to cook them adequately and perhaps insufficient cooking to destroy any possible pathogens. In a close examination of five cooked batches we noted an average of 1.9% of open mussels earlier deemed as cooked when they were in the cooking utensil were in fact inadequately cooked (Table 4, Appendix 4). i.e. undercooked as indicated by the uncoagulated nature of some of the “meat” and its adherence to the perimeter of the shell ( See Figure 1).



Figure 1. Undercooked mussels. The “meat” is not all coagulated and detached from the entire margin of the shell, in both mussels it is still attached to the margins of part of the shell in the upper margin of this picture.

An examination of seafood cookery books (Australian and others) in our personal library and a nearby municipal library indicated that consumers were “frightened of being poisoned “ from eating mussels as early as the 1880’s in the United Kingdom according to Cassells Dictionary (in Jane Grigson, 1993). But the now common advice to discard unopen mussels came to prominence in the mid 1970’s with the remark “Throw away any mussels that refuse to open” by Jane Grigson —the well known English writer—in her best selling book *Fish Cookery* published in 1973 and again in 1975.

Interestingly, two of the most influential food/cookery books of the 1960’s Larousse Gastronomique (Montagne 1965) and Elizabeth David’s *Italian Food* (1966) did not give any such warning in their discussion or recipes on mussels; nor did seven seafood cookery books published in the early 1970’s which we have examined. Grigson’s advice came at the end of a discussion on preparing and cooking mussels but gave no clear indication why the unopen mussels should be thrown away.

In all, this warning was given in two of the 15 seafood cookery books (13%) published in the 1970's and five of the 16 (31%) published in the 1980's that we consulted. By 1990 such advice was being repeated without question, or an explicit explanation why, and all of the 11 books published from 1990 to 2002 we have examined do so too. This view now seems entrenched with food writers and cookery teachers.

Our enquiry posted on the National Shellfisheries Association's (an international association of scientists and industry members) website Forum (on [www.shellfish.org](http://www.shellfish.org)) asking for information on the historical origins of this advice attracted 78 viewers over a 3 month period ending 31 December 2002 but no replies. The same enquiry posted on the seafood users group at the University of California Davis—used by food scientists, government regulatory authorities and industry personnel—elicited one response only while an email enquiry on the NSW TAFE cookery teachers' internal network elicited two responses.

The common thought amongst respondents was the fear of a dead mussel in a batch, particularly one full of mud, which might harbour some type of harmful bacteria, remaining closed after cooking. Further correspondence with these respondents revealed that the fear was based on outdated information on wild mussels (including product dredged from mud banks) without an understanding of modern aquaculture practices, the gaping of dead mussels or a knowledge of how mussels respond to heat in cooking.

Thus their fear was not based on fact or first hand knowledge. We regard this fear as unfounded, with Australian farmed mussels in particular, because of the following observations.

All or almost all dead mussels will have shells open and not closed — any rigor mortis is apparently very quick, especially when mussels are cooked. Furthermore any dead mussels which are closed before they are cooked are just as likely to open up with cooking as do the live mussels in the cook batch; dead *vis a vis* live mussels have no special properties holding the two shells closed. Also, live (closed) mussels are just as likely to harbour pathogens as are dead closed mussels in any batch, *if* the growing waters were polluted.

The mussels still unopen after cooking are therefore no more dangerous than the open ones, and as indicated above are arguably safer to eat given their greater exposure to heat.

Hence we see this now entrenched advice as unfounded. Therefore in the Trade Users Guide leaflet, and in the website version, cooks and consumers are advised to carefully examine mussels *before* cooking to detect and avoid cooking dead or doubtful mussels, which are more likely to impart unpleasant flavours rather than make consumers ill.

Nevertheless they are also reminded that some mussels do not open up even after excessive cooking and that these do not have to be discarded but rather they can be opened up (with a knife) and cooked a little more if they wish to do so.



It is noteworthy that several cookery writers who have had books published over a long time span advised readers to discard unopened mussels in books published in the 1990's while no such advice was given in their earlier publications in the 1980's. Personal discussions with two such writers, of national fame in Australia, revealed that the warning given in their latest publication does not represent their view but came from their young research assistants who did much of the work in preparing the latest book.

Further discussion with other food writers and cookery teachers leads us to conclude that this now widespread advisory note on mussels (and clams) is a case of writers and teachers repeating without question what appears to be good advice—albeit well meaning but unfounded. The contemporary situation is an outcome of a growing precautionary approach on public advice that has developed because of increasing food safety scares, class action compensation claims and a fear of litigation.

Water pollution is not new but Jane Grigson's 1975 somewhat confusing discussion on wild and sterilized mussels, quoted below, not only reflected the contemporary fear about water pollution and bivalve molluscs but gave unwarranted credibility to the view that mussels which do not open after cooking are unsafe to eat.

*"There is a word of warning. Don't let enthusiasm drive out common sense. Mussels are abundant around Britain. No need to set up mussel farms here with line after line of wooden stakes to entice them to our shores; in fact they need to be weeded out and transplanted, so that they can grow to their full size. This makes them a tempting prospect if you are on holidays at the seaside. Unfortunately sewage is as abundant as mussels, at least in many places, which means they can be quite unfit, even dangerous to eat. Mussels on sale at fishmongers have spent a suitable period in sterilized seawater cleansing tanks. This makes them safe. Cases of poisoning from mussels occur so rarely that they make the headlines when they do—which has the sad result of putting people off this most abundant form of delicious and cheap protein."*

## 5. BENEFITS AND ADOPTION

The greatest immediate benefit of this project has been the national acceptance of uniform practices and terminology on size grades and quality grades, a product specifications sheet and a standard method for assessing Mussel Condition Index or meat content to underpin the quality grading scheme.

The establishment of this industry wide framework for grading and labelling product allows for greater product and market diversification. This development offers consumers and trade buyers a greater choice of product size, quality and packaging. It also reduces the level of uncertainty on size and quality that has prevailed in the past.

Seafood wholesalers, retailers and restaurateurs will benefit from better handling practices on farm and consumers will quickly benefit from better quality mussels and the enhanced shelf life which will come from better handling by everyone in the marketing chain from retailer back to the farmer. Tangible results are not evident yet because the Code and the Trade Users Guide have only been available to most people over the past couple of months.

The forecasted economic benefits to accrue from increased consumer and trade confidence and a subsequent increase in demand and prices will come in 2004 and later years as farmers are able to alter their output and enhance mussel size and quality and sell larger and better quality mussels. Farmers unable to grow larger or better mussels too will benefit simply by adopting the national grading and labelling terminology.

Tasmanian farmers working through TASEA and Spring Bay Seafood have already adopted the new grading scheme as company practice and will quickly be able to turn out large high quality mussels this year. Farmers in Victoria, NSW, South Australia and Western Australia suffered from unusual oceanographic conditions in the spring of 2003 and are experiencing a shortfall of larger mussels and so are unlikely to produce substantial volumes of large high quality mussels before the second half of 2004.

Although the economic benefits are not measurable yet the strong interest in the grading of mussels and the strong demand for premium quality mussels augers well for the mussel industry. Together they suggest that the forecasted improvement of about 20% or more than \$1 million in aggregate national value over the next few years will be realised.

## 6. FURTHER DEVELOPMENT

The Australian mussel farming industry has the opportunity to raise consumer and trade awareness of Australian blue mussels, and aggregate demand, on the back of the new improved handling, grading and labelling practices adopted as a result of this R & D project with further media publicity.

Media publicity on the release of the Code and Trade Users Guide was limited to the media personalities who attended the formal release in Sydney in October 2003, at the request of farmers around Australia, because of the shortage of mussels around the country at the end of 2003. This limited media attendance nevertheless generated a lot of free publicity at a time when industry was unable to capitalise on it.

The publication and release of a new consumer oriented leaflet on handling and cooking Australian blue mussels, and related mussel tastings, offers another cost effective means of increasing awareness, demand — especially for better quality mussels — and hence aggregate returns to industry.

Farmers in Western Australia and Victoria have expressed an interest in producing an information-recipe leaflet and the principal investigator has encouraged them to try and work together to produce a national or generic leaflet or produce their own leaflet in a positive manner without unduly emphasising state of origin.

The Victorian Department of Primary Industries has also expressed an interest in participating in a mussel industry promotional function in Melbourne or Port Arlington and the release of a consumer oriented leaflet in 2004.

A Code Of Practice is a “living document” and not set in concrete. The quality grades and product specifications are new but not static and so should be reviewed and upgraded as harvesting, processing or marketing practices change or new technology and systems are adopted.

The Mussel Condition Index (meat content criteria for premium, regular and basic grade) in particular, needs to be reviewed by the grower’s association in each state in the first quarter of 2005, in the light of practical experience in the marketplace, after a full year of operation. These criteria and the Code should be re-endorsed or changed according to feedback from members, customers and consumers.

## 7. PLANNED OUTCOMES

As indicated earlier, all of the planned publications have been completed and released and are now available free to all Australian stakeholders via a variety of printed and electronic media.

The Research & Development results have been well received by industry and are being adopted throughout the country at different speeds according to the supply situation and market distribution arrangements in each state.

The consumer has yet to notice much change in retail outlets or restaurants because of the low profile or passive manner in which news has been released and the limited change in industry so far because of time lags in producing large mussels. Nevertheless feedback to date from farmers and media is very positive and most states are planning to have promotional and/or media functions later this year when the supply situation is favourable.

Farmers should therefore be more active in promoting the new practices in industry and the availability of defined quality grades to their customers and to consumers.

Our conclusion that the hitherto common advice to discard unopened mussel is unfounded and unnecessary in regard to Australian farmed mussels (if not all mussels) helps reduce some of the uncertainty or fear surrounding this bivalve mollusc. It has already generated positive feedback from food writers, retailers and restaurateurs because the Trade Users Guide and related publicity recommend the cook check mussels *before and after* cooking which means consumers and restaurateurs can stop throwing out good mussels.

This forecasted reduction in wastage makes mussels a more affordable seafood and represents an unplanned outcome of this R & D project of benefit to industry and consumers.

## 8. CONCLUSIONS

The adoption of the Code's uniform size and quality grading practises and terminology around the country provides a sound base for market promotion and further product development but it is really just the first step on the path to industry growth and maturity for Australian mussel farmers

The actual industry development and benefits which may accrue from this project will depend on how quickly and widely the farmers and their trading partners utilise the grading and handling practises, product specifications and terminology outlined in the Code and the Trade Users Guide.

The farmers should take the lead and stimulate interest and demand for the better grades of mussels. If they remain inactive or passive on industry and product promotion then much of the potential benefits of this R & D project will be lost.

It is the principal investigator's considered belief that the mussel industry can use the improved handling practices and mussel quality as a springboard to far greater national consumption of Australian blue mussels if it is prepared to invest in generic promotion.

This project has demonstrated that mussels are less dangerous than previously thought and the Trade Users Guide provides reliable information on how to enhance shelf life and advises the commercial or domestic cook on how to check mussels before and after cooking in order to get a tasty dish.

After all, Australian farmed mussels are a safe, versatile, delicious and inexpensive shellfish, with a positive public image but which have yet to be cooked at home by many Australians according to consumer research in Sydney and Perth by Ruello & Associates in 1999 and 2000.

## 9. REFERENCES

- Davenport J & X Chen, 1987. A comparison of methods for assessment of condition in the mussel (*Mytilus edulis* L.). *J. Molluscan Studies* 53(3) 293-297.
- David, E. 1965. *Italian Food*. 362 pp. The Cookery Book Club, London.
- Grigson, J. 1975. *Fish Cookery*. 423 pp. Penguin, England.
- Grigson, J. 1993. *Jane Grigson's Fish book*. 563 pp. Michael Joseph Ltd, London.
- Montagne, P. 1963. *Larousse Gastronomique*. 1098 pp. Fifth impression. Paul Hamlyn Limited, London.
- Ruello & Associates, 1999. A study of the retail sale and consumption of seafood in Sydney. FRDC project report 98/345. Vol. 1 173 pp. Vol. 2. 180 pp. Fisheries R & D Corporation, Canberra.
- Ruello & Associates, 2000. A study of seafood consumption in Perth and the development of a guide to targeted promotion. FRDC project report 99/342. 267 pp. Fisheries R & D Corporation, Canberra.
- South Australian Mussel Growers Association. 2001. *Code of Practice*. SA Mussel Growers Association. Port Lincoln, SA. 17pp.
- Tasmanian Department of Health 2001. *Code of Practice for operational practices in live shellfish packing and storage premises*. Tas. Dept. Health. Hobart. 25pp.

## **10. ACKNOWLEDGMENTS**

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## **11. APPENDICES**

APPENDIX 1      Post Harvest Code of Practice





## APPENDIX 2. Trade Users Guide Leaflet



## **TRADE USERS GUIDE TO WHOLE BLUE MUSSELS.**

This leaflet has been published to guide trade users such as restaurateurs, retailers and wholesalers on good handling and storage practices and to inform you about new developments in size and quality grading of whole Australian blue mussels. A more detailed version of this guide as well as the new Code of Practice adopted by Australian mussel farmers to improve the handling, grading and packing of live blue mussels are available from the website [www.seafoodservices.com.au](http://www.seafoodservices.com.au)

This Code of Practice defines three new quality grades (basic, regular and premium) and three size grades (cocktail, standard and large) for whole mussels so you now have a choice of clearly specified sizes and quality grades (subject to availability) as well as the traditional ungraded mussels.

All farmed mussels are grown in Australia according to a mandatory Shellfish Quality Assurance Program (SQAP) which regulates the food safety requirements. The farmers' new Code of Practice and this Guide thereby supplement the SQAP and help you to serve consumers with better mussels.

### **Part A      Guide For Seafood Wholesalers**

**Check for the name and address of the supplier , and date harvested, on all cases and bags.** Do not remove the packer's label or tag from the case or sack.

**Keep mussels cool, shaded and out of wind. Refrigerate or chill with ice immediately on receipt.**

**Store mussels in a cool room with temperatures between zero and 5°C**—lower temperatures will kill the mussels. It may be necessary to open the lid of a styrene case to accelerate chilling in the cool room if the mussels have warmed up in transit from the packer to you.

**Shelf Life And Stock Rotation :** Shelf life for good eating quality is limited to a total of about 7 days from harvest date if the mussels are held continuously at a cool room temperature of 0 - 5°C.

**Rotate stock in the cool room and sell on a First In First Out (FIFO) basis** so customers can enjoy the freshest mussels possible. Mussels more than 5 days from harvest date and held in a cool room will mostly be alive still but have limited shelf life remaining for your trade customers.

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Leaflet produced by Ruello & Associates Pty Ltd with R & D funding from Seafood Services Australia and the Australian mussel industry. October 2003.



**SEAFOOD SERVICES**  
AUSTRALIA

## **Part B      Handling And Display Guide For Retailers And Restaurateurs**

**Most of the mussels you bought are alive** but a few may have died during the cleaning or distribution process. Treat mussels like other fresh seafood and keep them refrigerated or cool with ice at all times.

**Store mussels in a cool room with temperatures between zero and 5°C**—lower temperatures or direct contact with ice will kill the mussels.

If you have bought an unopened case, open and drain the water from inside the case so that the mussels do not lie in the now dirty water. This water will get smelly with time even in the cool room and may contaminate the mussel flesh as the mussels open up.

**Cover the mussels with a clean wet towel** to protect them from drying out while in the cool room. Do not seal the mussels inside a closed styrene case.

**Rotate stock and sell on a First In First Out (FIFO) basis** so that that customers enjoy the freshest mussels possible. Good eating quality shelf life is about 7 days from harvest date if they are held refrigerated or iced.

**For retail or restaurant display.** Keep the container of mussels under refrigeration or embedded in ice so that they do not warm up; any in direct contact with a refrigerated counter or ice will die. Some mussels will open up with increasing time but live mussels close again if the shells are tapped or pushed together.

Avoid sunlight and other bright lights and wind or draughts, which will accelerate drying out and death.

**For restaurateurs: Care is needed before cooking** to ensure that only mussels which are alive or in a safe fresh condition are cooked. Mussels which do not close when tapped may be cooked (if previously held refrigerated or iced) if they have no unpleasant smell or other sign of spoilage. So wash and check mussels before cooking and discard any that are doubtful.

Farmed mussels will not all open up during cooking—some don't open up even after excessive cooking—but you do not have to discard these. Just open them up with a knife and cook a little more if you wish.

### APPENDIX 3. Trade Users Guide, Web version

Web Site Version



**SEAFOOD SERVICES**  
AUSTRALIA

## **TRADE USERS GUIDE TO WHOLE BLUE MUSSELS**

**Developed by Ruello & Associates Pty Ltd**

This guide has been produced to advise trade users of fresh Australian blue mussels such as restaurateurs, retailers and wholesalers on good handling and storage practices for whole mussels (live and chilled) so that you can add on to the farmers' quality control program and get greater satisfaction from mussels.

**All farmed mussels are grown in Australia according to a Shellfish Quality Assurance Program (SQAP) which governs the food safety requirements** of these shellfish. All cases or sacks of mussels should have a label or tag attached by the grower/packer indicating the approved growing areas from which the mussels come and information for trace back to the packer (in case of problems or need for a product recall).

Australian mussel farmers have recently adopted a newly developed national *Code of Practice* for improving the handling, grading and packing of live mussels. This Code of Practice defines three new quality grades (basic, regular and premium) and three size grades (cocktail, standard and large) so you now have a choice of clearly specified sizes and quality grades (subject to availability) as well as the traditional ungraded mussels.

The availability and price of the mussels will, of course, depend on your supplier and seasonal conditions in each growing area. The "meat" content and condition of mussels varies throughout the year as the mussels mature, spawn and lose condition, and then gradually regain weight again.

Mussel condition or meat content is the critical quality factor in the new quality grading scheme and a simple method has been developed to allow everyone to quickly assess this Mussel Condition Index (MCI).

The specifications for the three size and quality grades are shown in the accompanying table and the entire Code, including the MCI assessment method, is available for viewing on [www.seafoodservices.com.au](http://www.seafoodservices.com.au)



Premium Quality Grade mussels, female and male, left to right.



Premium, Regular and Basic Quality grades; all females about 75 mm in length (Standard size grade).

## Part A

### Guide For Seafood Wholesalers

#### Food Safety Check On Receival

Check for the name and address of supplier, and date harvested on all containers. **Do not remove this label or sticker from the case or sack.**

**Keep mussels cool, shaded, and out of the wind.**

Mussels live underwater in a dark environment with fairly stable cool temperatures. In handling mussels it is advisable to keep them cool, avoiding fluctuating temperatures, heat, sunlight (and other bright light) and wind or draughts, which will accelerate drying out and death.

Although most of the mussels you buy are alive a few may have died during the cleaning or distribution processes and so it is best to treat your mussels as a fresh seafood and **refrigerate or chill with ice immediately on receival.**

This is critical if the mussels have not been chilled by the farmer or packer before delivery to you.

While a SQAP regulation stipulates that growers should discard all dead, damaged or gaping shellfish it takes no account of the human limitations of quality control checks when millions of mussels are being packed each day. Nevertheless, a few dead or cracked mussels may be packed so any mussels that die at ambient (air) temperature may be unsafe to eat and must therefore be discarded.

#### Storage

**Store mussels in a cool room with temperatures between zero and 5°C**—lower temperatures will kill the mussels. Ice in direct contact with mussels will also kill them. So if ice is to be used for cooling at any time it is best to place a clean sack or towel between the mussels and the ice to produce a “shower” or “curtain” of melting ice water over the mussels.

#### Styrene or cardboard cases

Remember the styrene or cardboard case is designed to maintain a low temperature in transit by protecting the chilled mussels against warming from air outside; but the insulating properties of styrene also means that the mussels inside the sealed styrene case will cool down slowly in the cool room.



It will be necessary to open the lid of a styrene case to accelerate chilling in the cool room if the mussels have warmed up in transit from the packer to you.

**If the mussels are to be held for a couple of days, drain the water from inside the plastic liner bags** so that the mussels do not lie in dirty water. This water will have some debris and bacteria draining from the outside of the mussels and will get smelly with time even in the cool room and may contaminate the mussel flesh as the mussels open up with increasing time after harvest.

### **Sacks And Plastic Fish Bins**

Allow water to drain off the mussels, cover with a clean wet towel or clean sack to prevent drying out and then store them in a cool room. Sacks of mussels should be held on a pallet or otherwise kept off the floor.

### **Shelf Life And Stock Rotation**

**Shelf life for good eating quality is limited to a total of about 7 days from harvest date** if the mussels are held continuously at cool room temperatures of 0-5°C. So stock control is important, especially in summer when higher temperatures prevail.

**Rotate stock in the cool room and sell on a First In First Out (FIFO) basis** so that customers enjoy the freshest mussels possible. Mussels that are more than 5 days from harvest date and held continuously at refrigeration temperatures, will mostly be alive still but have limited shelf life remaining for your trade customers.

**Table 1. Product specifications sheet for fresh blue mussels.**

| Product feature                          | Basic Quality grade  | Regular Quality grade  | Premium Quality grade  |
|--|--|--|--|
| Size grading                             | No warranty on size grading  | No more than 8 out of grade per 5kg for large size grade and no more than 12 for the standard size category. | No more than 4 out of grade per 5kg for large size category and no more than 6 for the standard size category. |
| Mussel (meat)<br>Condition Index         | No warranty on Mussel (meat)<br>Condition Index                                | Average MCI 28.0-39.0%   | Average MCI more than 39.0%.<br>No more than 10% of mussels with less than 30% meat content                    |
| Shell cleanliness                        | Heavy fouling acceptable   | Majority of mussels (>50%) are clean of heavy fouling  | Most mussels (>90%) are clean of heavy fouling   |
| Temperature Control                      | Mussels may not have been chilled by grower or packer.                         | Mussels have been chilled by grower or packer to less than 10°C before shipment.                             | Mussels have been chilled by grower or packer to less than 10°C before shipment.                               |
| Flavour                                  | No bitter flavour present  | No bitter flavour present  | No bitter flavour present  |
| Harvest date and other label information | Date of harvest and all necessary (government) information shown on all packs. | Date of harvest and all necessary (government) information shown on all packs.                               | Date of harvest and all necessary (government) information shown on all packs.                                 |
| Crabs & Parasites                        | Not examined for pea crab or internal parasites                                | Practically free of pea crab and internal parasites  | Practically free of pea crab, no obvious impact of internal parasites per 5 kg                                 |
| Packing weight                           | Overpack by minimum of 5%  | Overpack by minimum of 5%, more for distant transport  | Overpack by minimum of 5%, more for distant transport  |

**Size grades for fresh Australian blue mussels (based on mussel shell length)**

Cocktail: 55-80 mm  
Standard: 65-80 mm  
Large: 80 + mm

## Part B

### Holding And Display Guide For Retailers And Restaurateurs

Although most of the mussels you receive are alive a few may have died during the cleaning or distribution processes and so it is best to treat your mussels as fresh seafood and keep them refrigerated or cool with ice at all times.

Mussels live underwater in a reduced light environment with fairly stable cool temperatures. In handling and displaying mussels it is advisable to keep them at a temperature between zero and 5°C, avoiding fluctuating temperatures, sunlight and other bright lights and wind or drafts which will accelerate drying out and death. Direct contact with ice will kill mussels.

All mussels are grown in Australia according to the requirements of a Shellfish Quality Assurance Program so when buying a sealed full case check that it has the packing date and details on the packer's address for trace back to the packer in case of problems or need for a product recall. Do not remove this label or sticker from the case.

Refrigerate mussels as soon as possible after receipt, even those in styrene cases. Remember the styrene case is designed to maintain a low temperature in transit by protecting the chilled mussels against warming from air outside; but the insulating properties of styrene also means that the mussels inside the sealed styrene case will cool down slowly in the cool room.

It is advisable to drain the water from inside the styrene case so that the mussels do not lie in the now dirty water. This water will have some debris and bacteria draining from the outside of the mussels and will get smelly with time even in the cool room and may contaminate the mussel flesh as the mussels open up with increasing time out of water. Cover the mussels with a clean wet towel to protect them from drying out while in the cool room.

### Shelf Life

Rotate stock and sell on a First In First Out (FIFO) basis so that customers enjoy the freshest mussels possible. Good eating quality shelf life is limited to a total of about 7 days from harvest date if held refrigerated or iced.

**For retail or restaurant display.** Keep the container of mussels under refrigeration or embedded in ice so that they do not warm up; any in direct contact with a refrigerated counter or ice will die. Keep mussels away from bright light, wind and air conditioning outflow if you wish to keep them alive.

Some of the mussels you have bought will have opened up; this is normal as they have been out of seawater.

**For restaurateurs:** Care is needed before cooking to ensure that only mussels which are alive or in a safe fresh condition are cooked. Mussels which do not close their shells when they are tapped or pushed together may be cooked (if previously held refrigerated or iced) if they have no unpleasant smell or other sign of spoilage. **So wash and check mussels before cooking** and discard any that are doubtful.

Farmed mussels will not all open up during cooking —some don't open up even after excessive cooking— but you do not have to discard these. You can open these up with a knife and cook a little more if you wish to be extra sure.

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Guide produced by Ruello & Associates Pty Ltd with R & D funding from Seafood Services Australia and the Australian mussel growing industry.  
October, 2003.

## APPENDIX 4. Observations on mussel cooking and opening.

All observations on cooking were done with mussels bought from wholesalers at the Sydney Fish Market as a full unopened styrene case of 5 or 10 kilograms. The handling and temperature history was unknown but all mussels cooked were no more than five days post harvest.

Mussels were steam cooked in a large, lidded frypan or boiler starting with 1 centimetre of water. As the shells opened up and the “meat” looked cooked, i.e. coagulated and shrunken from the shell margins, they were removed from the cooking utensil. The actual steaming time for each individual mussel varied from less than a minute for the early openers in a small batch (<30 mussels) to more than five minutes for some late openers in a large cook batch (>60 mussels).

Table 1. Percentage of mussels cooked which did not open

| Date          | Percentage Unopen | Number unopen/open |
|---------------|-------------------|--------------------|
| 9 Feb 2001    | 27.9              | 31/111             |
|               | 12.5              | 9/72               |
|               | 53.0              | 35/66              |
| 28 Dec 2001   | 16.1              | 9/56               |
|               | 25.0              | 22/88              |
| 19 Jul 2002   | 3.9               | 6/88               |
|               | 3.0               | 2/66               |
| 2 Aug 2002    | 2.1               | 1/48               |
|               | 3.3               | 1/60               |
| 28 Aug 2002   | 1.4               | 1/72               |
|               | 3.5               | 2/57               |
| 14 Jan 2003   | 16.4              | 11/67              |
|               | 0                 | 0/62               |
|               | 16.5              | 5/77               |
| 28 Feb 2003   | 13.8              | 4/29               |
|               | 27.4              | 14/51              |
| 3 March 2003  | 11.5              | 6/52               |
|               | 18.3              | 11/60              |
| 20 March 2003 | 5.0               | 1/20               |
|               | 18.3              | 11/60              |
| 23 March 2003 | 10.0              | 2/20               |
|               | 18.3              | 11/60              |
| 3 Apr 2003    | 5.0               | 1/20               |
|               | 15.0              | 3/20               |
|               | 10.               | 2/20               |
|               | 10.0              | 2/20               |
| 12 Sep 2003   | 5                 | 1/20               |
|               | 0                 | 0/20               |
|               | 0                 | 0/36               |
| 20 Sep 2003   | 5.0               | 1/20               |
|               | 5.0               | 1/20               |
| 30 Oct 2003   | 5.0               | 1/20               |
| Average       | 11.5              |                    |

Table 2. Mussels unopen but noted as adequately cooked (and total number cooked)

| Date        | Number open | Total number cooked |
|-------------|-------------|---------------------|
| 9 Feb 2001  | 31          | 111                 |
| 2 Aug 2002  | 1           | 48                  |
|             | 2           | 60                  |
|             | 2           | 57                  |
| 28 Aug 2002 | 1           | 72                  |
| Total       | 37          | 348                 |

Table 3. Percentage of unopen mussels after typical cooking time and after 90 seconds extra cooking time.

| Date        | Number cooked | % Unopen with typical cooking | % Unopen after extra cooking time |
|-------------|---------------|-------------------------------|-----------------------------------|
| 9 Feb 2001  | 72            | 12.5                          | 8.3                               |
|             | 66            | 53.0                          | 30.0                              |
| 28 Dec 2001 | 56            | 16.1                          | 8.9                               |
|             | 88            | 25.0                          | 13.2                              |

Table 4. Percentage of cooked open mussels subsequently noted as inadequately cooked (undercooked).

| Date        | Percentage inadequately cooked | Number undercooked/cooked |
|-------------|--------------------------------|---------------------------|
| 19 Jul 2002 | 2.4                            | 2/82                      |
| 2 Aug 2002  | 2.1                            | 1/47                      |
|             | 1.7                            | 1/60                      |
|             | 1.8                            | 1/55                      |
| 28 Aug 2002 | 1.4                            | 1/71                      |
|             | 1.9 Average                    | Total 6/325               |

## APPENDIX 5. Intellectual Property

The intellectual property of this project resides with the Fisheries Research & Development Corporation.

## APPENDIX 6. Project Staff

The project staff was Nick Ruello and Judith Woods.