

REVIEW OF RESEARCH ON THE GIANT CRAB FISHERY

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FINAL REPORT





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The tasks to be done in this review were:

1. Review all previous FRDC-funded research on Giant crabs;
2. Review all documents pertaining to 1. as supplied by FRDC;
3. Meet with relevant scientists and managers in Victoria and Tasmania and discuss previous research on Giant crabs (funded by FRDC and others), current and future management needs and future research priorities;
4. Prepare a document summarizing the findings of 1., 2. and 3. above and recommend how FRDC should best proceed with future R&D funding support for Giant crabs.

This review document is in three parts: (i) a list of the documents and meetings from which the review was derived; (ii) the general findings of the review and recommendations to FRDC; and (iii) detailed comments on the more important documents reviewed.

(i) Documents reviewed:

1. Original FRDC application from Deakin University. FRDC project number 93/220.
2. Draft preliminary report by Deakin University, July 1999.
3. FRDC application from Deakin University. FRDC project number 97/132.
4. McGarvey, R., Matthews, J.M. & Levings, A.H. (1999) "Yield-, value-, and Egg-per recruit of giant crab, *Pseudovarcinus gigas*." Report.
5. Ford, W. (1999). Summary report on the giant crab workshop. Held in Adelaide, November 1998.
6. Preliminary FRDC application to FRDC and the Tasmanian FRAB. "Development of abundance estimation techniques for giant crab assessment". By University of Tasmania, 1999.



7. Preliminary FRDC application. "Yield, egg and value per recruit and thermal model validation for the giant crab fishery of Southern Australia." By Deakin University, 1999
8. SPIRT Grant application for year 2000 grants. "Ageing giant crabs by two novel techniques - radioisotope ratios and lipofuscin fraction". University of Tasmania and TAFI.
9. Giant crab research proposal notes. Caleb Gardner's notes for the preparation of a new FRDC application, 2000.
10. McGarvey, R., Levings, A.H. & Matthews, J.M.(submitted manuscript). "Moulting growth of Australian giant crab (*Pseudocarcinus gigas*). Mar. Freshwater. Res.
11. Murphy, N.P. "Molecular genetic studies of the giant crab *Pseudocarcinus gigas* (Lamarck) (Decapoda: Oziidae)". B.Sc. (Hons) thesis, Deakin University.

Meetings and discussions held:

1. Meetings with University of Tasmania and TAFI staff, 24th May, 2000 in Hobart. Personnel: Caleb Gardner, Malcolm Haddon, Stuart Frusher and Wes Ford.
2. Attended presentation on giant crab research by Andrew Levings in Launceston, 25th May, 2000.
3. Meetings with Andrew Levings, 25th and 26th May, 2000 in Launceston.
4. Sundry telephone conversations with Caleb Gardner, Andrew Levings, Wes Ford and David Hobday (Victoria).
5. Numerous telephone discussions and one meeting with Patrick Hone of FRDC.

(ii) General findings and recommendations

From all the discussions, meetings and literature examined during this review, several aspects of past, current and future investment into research on giant crabs by FRDC have become evident. Initially I will discuss these separately for the situations in Tasmania and Deakin University before discussing their combination.

1. The Tasmanian situation:

Tasmania has by far the largest catch of giant crabs in Australia (100 tonnes compared to 30-40 tonnes in Victoria and even less in South Australia and Western Australia) so, in terms of simple economies of scale, one would expect that maximal benefit would arise by investing any



future research spending (if required) in the Tasmanian part of the fishery. Discussions with Tasmanian fisheries managers and researchers revealed that their most pressing research requirement is to develop a mechanism by which they can adjust their TACC for giant crabs (currently set at 100 tonnes). It is therefore crucial that any future research direction for giant crabs has, as its primary outcome, the supply of information necessary to support fisheries models that will permit TACC recommendations. This will involve the development of a TACC-based population model and a long-term monitoring regime to support it. This would ideally be developed in Tasmania first and then be extended to other states afterwards (Fisheries staff in other states have indicated that a similar TACC-based management regime will be implemented in South Australia and probably Victoria).

To arrive at such an outcome, it is apparent that Tasmania requires a methodological research project to develop a low-cost, industry-based monitoring programme, the data from which will feed a population model whose primary purpose will be the delivery of TACC recommendations. Such a methodological project will have to be industry-based because: (i) there is only a modest amount of funding available for on-going monitoring (in Tasmania this is approximately \$30,000/year) and (ii) this fishery occurs in deep water, with only small numbers of animals caught per day, precluding most forms of fishery-independent sampling. In order to develop a low-cost monitoring programme, TAFI intended to approach FRDC to fund such a methodological project for three years in the order of \$180 - \$200,000/year. This project would explore a variety of industry-based techniques for sampling quantities and size-structures of giant crabs (including, for example, detailed logbooks, onboard observers, photographic sampling of catches by fishers at sea, dockside sampling, etc.) in addition to the development of a size-structured model for the fishery.

While in Hobart, I was also shown the work that TAFI are currently doing on ageing giant crabs (via a SPIRT grant) as well as previous research done by Dr Gardener. Modellers at TAFI indicated that, whilst the development of a model and a low-cost monitoring programme would incorporate the results from their ageing work and the above-mentioned methodological project, this would be greatly enhanced by incorporating the tagging, and other fishery-dependent, data collected by Deakin University over the past 6 years (see below). It is worth noting here that Tasmanian Fisheries have substantial research funds available to spend on giant crab research. This is in the form of a large amount of money currently available, and the above-mentioned \$30,000 per year for a monitoring programme.



A secondary management priority in Tasmania is an assessment of the appropriateness of the current minimum size limit for giant crabs (150mm). It has been suggested by several scientists that this size limit is probably appropriate for females but that only the first mature male instar is protected (see below). It was indicated that TAFI staff would probably monitor females for decreasing numbers and sizes of spermathecae to assess any impacts of the size-limit on male reproductive success. This would be a relatively inexpensive project and not require FRDC funds.

2. The Deakin University situation:

The most relevant aspect of research on giant crabs for this particular review was the large amount of research done by Deakin University over the past 6 years using FRDC funding (to the order of \$866,829). Unfortunately, this work has not yet yielded a final report. Early in my discussions with Deakin University staff, when it became apparent that they were considering applying for more FRDC funding on giant crabs, I pointed out that I doubted if FRDC would consider any more applications for funding giant crab research from Deakin University without having received the final report from the previous project(s).

It is a major problem that FRDC did not insist on receiving a final report from the first three years of the Deakin University study before funding the last 3 years of work. Without such a report, Deakin University has done the latter work without the benefit of solid peer-review and/or critiques of previous research methods, analyses, etc. and, more importantly, without input from fisheries managers in terms of management priorities which should have driven future research directions. It is important that this mistake is not made again and that a clear signal is sent out to all research providers that this situation will not be repeated. This can be best achieved by FRDC not funding any more research into giant crabs (by any agency) until Deakin University complete their final report.

Despite this history, I examined the work done by Deakin University and the current progress on their final report (for detailed comments on a very early draft of the final report, see below). In summary, I can report that a great deal of research on giant crabs has been achieved over the past 6 years by Mr Levings and Deakin University and that, because of this work, Australia (or at least the staff at Deakin University) now know a great deal more about this animal and its fishery than was the case 6 years ago. It is unfortunate, however, that such knowledge has not yet reached all the main stakeholders in this fishery - but the production of the final report should fix this. Basically, I can report that most of the objectives from FRDC projects 93/220 and 97/132 are being met in the final report and I have no doubt that the



report, once finished, will be excellent. I examined the latest drafts of most sections of the report, many of the figures and tables (that are mostly ready for printing) and conclude that the main work required to complete the report is for Mr Levings: (i) to write some text on male reproduction; (ii) to tidy up the text on population structures; (iii) to finish a chapter on movement and oceanography; and (iv) to write the General Discussion. All other parts of the report seem to be completed. Mr Levings assures me that all will be complete by the end of June and there is no reason that I can determine why this should not occur. During my examination of the latest draft of the final report, Mr Levings also furnished me with several drafts of papers arising from the project that have been submitted to journals and an ancillary Honours thesis on mitochondrial DNA work. I conclude that the money invested in giant crab research by FRDC's Deakin University project(s) over the past 6 years was spent reasonably well but its direction would have benefited greatly from critical review by other scientists and the managers of the fishery at regular periods (especially after the initial 3 year project).

I also had the opportunity to see a presentation by Mr Levings to a group of lobster/giant crab fishermen. This presentation was well done and well received by the fishers, convincing me of Deakin University's expertise in developing and maintaining data-collection programmes that are industry-based. Mr Levings' presentation focused on several aspects of the work done over the past 6 years by describing the fisher-network used to gather data, the extensive tagging programme that has been in operation for several years, various aspects of the animal's biology, such as its fecundity, growth, movement, etc., and the relationship between patterns of abundance and oceanic thermoclines. The presentation concluded with the interesting deduction that giant crabs seem to adhere to a thermal niche of approximately 12°C. Mr Levings also provided insights into the animal's evolutionary history and its relationship to various oceanographic processes and continental drift. Whilst all this information was interesting, well-described and well-received by the audience, its immediate application to managers requiring a means to adjust a TACC and the minimum legal size limit is indirect at best and marginal at worst. This sort of information may prove useful should managers require a sophisticated model to manage this fishery but the value and size of the fishery suggest that a less sophisticated, lower-cost alternative may be appropriate. So, while information on the abundances, movements, evolution, thermal niches, etc. of giant crabs is good to have, there appear to be higher priorities for future research into this animal and its fishery at this particular time.



3. Recommendations:

A major part of the Deakin University study was the development of industry-based techniques to obtain data on populations of giant crabs throughout southern Australia (albeit with relatively less sampling done in Tasmanian waters). The main requirement of fisheries managers and researchers in the main state involved in this fishery - Tasmania (and eventually the main requirement for other states) - is a methodological project that will examine, assess and develop industry-based techniques to obtain data that can be used in population models designed to provide recommendations regarding TACCs. Should TAFI do such a project in isolation from the expertise at Deakin University, there would be a significant amount of duplication of the work already done. Obviously this should be avoided. The ideal solution would be for TAFI to develop a joint methodological project that would combine the expertise, information and raw data gathered during the Deakin University project, with the modelling expertise, scientific background, current ageing work and management purpose that reside in Tasmania.

Strategically I would recommend that FRDC:

1. Defer a decision on any further applications for funding research on giant crabs from any agency until after the final report for the Deakin University study is complete and submitted to FRDC, including all its raw data.
2. After this report and data have been received, I would recommend that all should be given to TAFI for their scrutiny and use in their modelling work - that will also incorporate their new ageing results and any other data currently being gathered. This work (done at TAFI's expense) should attempt to develop a population model that will, at best, allow adjustments of the TACC or, at worst, provide a means to better design (and so reduce the costs associated with) a new "methodological" project.
3. After TAFI have had the opportunity to take advantage of the data from Deakin University and their own ageing results, they should then apply to FRDC with an application to fund the "methodological" project whose objective will be to develop, over 3 years, a low-cost, long-term, industry-based monitoring programme which will feed a population model that is designed to provide recommendations on TACCs. This application should have TAFI as the lead agency with Deakin University supplying their industry-based expertise as co-investigators or consultants.

If this strategy is adopted it should cost FRDC nothing in the short-term and less in the medium term by hopefully reducing the costs of the eventual methodological project - if TAFI



modellers are able to use the information and data from Deakin University, their own ageing results and other data-collection programmes to develop a leaner methodological project proposal than would be the case now. It will also ensure the production of the final report by Deakin University and the maximal use of that information by modellers and managers. Further, by focusing on Tasmania first, the fisheries in Victoria, South Australia and West Australia should be advantaged in the long run after Tasmania has done the ground-work in developing the low-cost monitoring programme and the necessary modelling for adjusting TACCs. If all this occurs within the next two to three years, the ultimate goal will be to simply extend the monitoring programme and modelling work interstate and eventually establish a TACC for all states combined.

In terms of assessing the minimum size limit, I would recommend that firstly McGarvey et al.'s yield per recruit models (developed with data from Deakin University) be run for Tasmanian data as soon as sufficient data can be obtained. Such data may already be available but if not, then this may have to wait until during or after the methodological project outlined above. In the meantime, I would suggest that the spermathecae-monitoring project be done by TAFI (at their expense since it was noted to be relatively cheap and they have sufficient funds to cover this). This would allow at least some check on the status of the minimum size limit's influence on male reproductive success in Tasmania at a low cost.

(iii) Detailed comments on the more important documents reviewed.

1. Original FRDC application from Deakin University. FRDC project number 93/220.

This application sought funds to determine basic biology and fishery information for giant crabs which, back in 1993, was a virtually unstudied animal and fishery. On the whole, this application contained good initial ideas, the main exception would be the attempt to do a fishery independent survey of such a low-volume, deep water fishery.

2. Draft preliminary report by Deakin University, July 1999.

In general:

This document is a preliminary final report covering the first 3 and a half years of Deakin University's six years of FRDC funding over 2 projects and was written following pressure from FRDC concerning the lack of reporting from the project. This document seems to attempt to alter the conditions of the original FRDC grant by referring to the initial three year study as a "pilot study". This is done under the proposition that the proposed development of



a fishery model for giant crabs was not possible due to the slow growth of the animal, despite this being one of the objectives of the initial application. Rather than report on the model, this report is a summary of the basic biological and population information gathered during the first years of the study. Such a report is probably reasonable in hindsight because it is not surprising that the wish list in the initial application (see page 6 of the document) was not delivered. If the final version of this report (which is now supposed to encompass both projects and 6 years of funding) does provide the information listed on page 7 of the document, then FRDC could consider that they received fair value for their investment. However, FRDC should be very careful about further investment in giant crab research by Deakin University because of their track record in meeting reporting requirements.

In general this document is a mess and very disappointing (even for a preliminary report) for a project that has attracted over \$800,000 and took 6 years. It doesn't provide proper analyses of the data collected, only superficial treatments. Deakin University should be required to produce the final report in a form that can be digested, reviewed and used by others. The report needs to be structured much better with clear headings and subheadings. Throughout the document the introductions, methods, results and discussions are mostly jumbled. There are lots of figures presented that are not mentioned in the text and there are lots of text in the report about non-existent figures.

The fisheries information section of the report (section 2) provides a reasonable history but should make more mention of the pitfalls and assumptions that are inherent in fisheries-dependent data. That is, while the approach of using fishers to gather data is appropriate for a low volume, deep water fishery like this, the authors need to be very careful about the quality and interpretation of such data. Some of the authors' interpretations are, at best, guesses and should be stated as such. The biological information section (section 3) describes fishery-dependent and fishery-independent sampling, the proposed sampling designs, the logistical problems encountered and the compromises that had to be made as a consequence. The very ambitious sampling regimes that were intended failed and had to be altered. The low numbers of crabs that were sampled in the fishery independent work seemed to be ignored so that the report now mostly contains information from the fishery dependent sampling. However, the report states that it also includes data from fishery-dependent catch data and data from "research sampling", making it impossible to distinguish the relative contributions of each.

Despite the poor quality of this draft, the research outlined has definitely led to a lot of new information about this animal and its fishery. One particularly positive result was the



recommendation and subsequent establishment of a minimum legal size for giant crabs of 150mm - such a real management change can be considered as a good outcome from this research.

In detail:

P. 8 - mention is made of joint work with other projects at Deakin University. Were any savings of FRDC funds achieved from such joint work?

P. 13 - a great deal of jurisdictional history is provided here that is tangential to this project's objectives but nevertheless it provides sound background. Pages 15, 16, 17 provide an excellent description of the fishery.

P. 20, para. 2. A very minor point: In 1993 the price per kilogram for giant crabs was listed as \$9, \$7 and \$5 for <3, 3-5 and >5kgs but this changed in 1996 to \$14, \$21 and \$27 (see also Fig. 2.5.1b). Are these numbers meant to be "respectively"? Or were bigger crabs cheaper in 1993 compared to 1996?

P. 20-22. The point is made here about problems with industry data collection but this should be expanded and consistently discussed throughout the report because this is a key aspect of this study - in terms of the data's utility, accuracy and reliability.

P.22, para. 6. "section 3.7 below" is mentioned but this occurs nowhere near here. Fig. 3.7.2.1 is mentioned but is absent. P. 22 also mentions issues concerning the confidentiality of data, implying that data from log books, etc. is not being made available. Yet one of the major positives about this research is that the author states that it has been successful in establishing an industry-based data-collection regime. Such a regime would be useless if the data is not being made available due to confidentiality problems.

P. 24, para. 3. Repetition of information already mentioned earlier.

P. 24, last para. There are numerous unsubstantiated inferences about the movements of giant crabs that are based on very limited data. These inferences are tangential to the project's objectives and not even presented in this report (or even referenced to some other source).

P. 25. The discussion on this page draws a very long bow with very limited data

P. 26. It is impossible to determine which line refers to which data and on P. 27, it is difficult to discern coloured histograms in black and white photocopies.

Section 3.2.2 has no text.



P. 40. Like many other studies that have attempted to sample crab megalopae on fishing floats and headgear, this work showed that the wrong species were sampled and the research was subsequently abandoned. It was, however, probably worth an attempt to sample such larvae. However, in abandoning this work, were there any cost savings to FRDC?

P. 41. This is repetitive.

P. 40-42. The preliminary information on the tagging work is quite good.

P. 43, paras 4-5. It is noted that 58 recaptured crabs had moulted. Why does the author not attempt to analyse these data here? - It is a requirement of objective 1 of the project.

P. 49-51. All this detail is interesting but is it necessary?

P. 51. A great deal of speculation here.

P. 51, para. 4. Was the work on enzyme heterozygosity done in this project or elsewhere? If the former, where are the data?

After page 51 the report seems to ramble and becomes even more jumbled than previously. The page numbers are missing. To what section does 3.3 methods refer? Section 3.6 is a list of things that seem to be unrelated to anything else and this entire section seems to contain large pieces of random bits of introduction, methods, results from this study and other studies all jumbled together. It is very difficult to determine what is part of this study and what is not.

Section 3.6.3.1, para. 2 refers to Fig. 20 which doesn't seem to exist. Like the various pieces of text in this document, the section numbers, figures and table numbers are completely confusing. The many pages of ANOVAs and SNK tests need to be summarised properly into one or two tables and interpreted in a block of text - not jumbled over 20 odd pages. It is unclear whether it is even valid to even use such tests on these biased, fishery-dependent, non-independent data.

On the page immediately following all the ANOVAs and SNK pages there is a great deal of speculation.

3. FRDC application from Deakin University. FRDC project number 97/132.

This application for funding mentions information from the preliminary report discussed above but such information was not actually in that document (in particular the information on inter-moult period). This application is basically a second grab for large



quantities of money to continue the former work and analyse it using various models. It is very surprising that this application was successful WITHOUT a final report from the first 3 years.

4. McGarvey, R., Matthews, J.M. & Levings, A.H. (1999) "Yield-, value-, and Egg-per recruit of giant crab, *Pseudovarcinus gigas*." Report.

In general:

This report purports to provide some of what document 3 applied to do. In general the model developed is quite good. Like all fisheries models, it contains many assumptions, but it is still a useful and worthwhile first attempt at modelling these populations. The yield per recruit work was only done for Western Australia, South Australia and Victoria. It is unfortunate that the most important state for this fishery (Tasmania) was not included - apparently because of a lack of data. A suggestion for future work would be to get as much of the necessary data from Tasmania as possible to run the model by McGarvey et al. for Tasmania. This would be a relatively cheap way to get yield per recruit estimates for the Tasmanian stock which would allow some comment to be made on the appropriateness of the current minimum size limit - a priority for Tasmanian fisheries managers, that is secondary to adjusting the TACC.

The report concludes that the legal minimum length for giant crabs is more or less appropriate for females. However, while male reproductive success was not actually examined in this study, the authors nevertheless concluded (based on another paper) that only the first mature male instar is protected by this size. This led to the recommendation that females should be monitored for decreasing numbers and sizes of spermathecae as a way to monitor any impact of the size limit on male reproductive success. This is a sound idea because it is also relatively cheap.

The chief problem with this report is that there is very little interpretation of the main results. The discussion describes a few of the problems with the analyses and their interpretation and recommends one priority for future research (the spermathecae survey mentioned above), but there is little discussion of the results from the yield per recruit modelling - the actual subject of this report. Despite all this, this document is a vast improvement in our knowledge of giant crabs compared with what was known previously (basically because this is the first attempt to model this fishery).



In detail:

P. 4. Is the Mitchell and Levings' report referred to here the final FRDC report for 1993/220. If so, it is hardly a final report.

P. 4. There are no correlation co-efficients for these relationships and the curves drawn seem to extrapolate too far past the data available. What are the two lines in Fig. 1.1? There is no caption but I assume that the lines refer to males and females.

P. 6. The growth data mentioned here was supposed to have come from Mitchell and Levings but those data are not in that document.

P. 6, para. 3. Why only "visual" examination? Why didn't the authors test this relationship by a regression of growth increment versus length?

P. 15, last para. For males this assumption may be appropriate but females may also moult when males moult in December. To assume that females moult in June because some fishers reported seeing a few clean-shelled females during that month is very speculative.

P.18, last 2 paras. Why are inter-moult periods given for 120, 180 and 150 mm. This is a strange order.

P. 33, 4th line. I thought that it was a requirement to discard egg-bearing females?

P. 36, para 2. Authors forgot to replace "fish" with "crabs".

P. 46. This is a good check of the model and a sound interpretation of these checks. There is also a worthwhile description of the differences between the observations and the predictions for the model.

P. 46-47. In general the modelling on growth is quite good and comprehensive.

P. 68. The statement that "natural mortality is the most sensitive parameter" is of some concern because the natural mortality rate used (0.6) was derived more or less arbitrarily. However, this is a problem with most fisheries models.

P. 68, Discussion, line 4. References should be included to support this.

5. Ford, W. (1999). *Summary report on the giant crab workshop. Held in Adelaide, November 1998.*

This is an excellent summary of all that was known about giant crabs at the time. It includes succinct summaries of the species' biology, preliminary results from the Deakin University study, catches and catch rates throughout Australia, and current management



issues. The latter included the size limit of 150mm protecting females adequately but perhaps not males and it was noted that this may be addressed by the relatively cheap monitoring programme of spermathecae mentioned above. Unfortunately, the key purpose of this workshop, which was to determine future assessment measures and directions for research were hardly addressed at all due to time constraints! This workshop therefore, despite its promise, “fell over at the last hurdle”.

6. Preliminary FRDC application to FRDC and the Tasmanian FRAB. “Development of abundance estimation techniques for giant crab assessment”. By University of Tasmania, 1999.

This pre-proposal has sound and focused objectives. It basically involves: 1. an examination of several industry-based methods designed to obtain data for modelling purposes at a low-cost; and 2. modelling work to develop a size-structured model with which recommendations for the TACC will be determined. This is basically the sort of “methodological” project referred to in my recommendations above. One must conclude, however, that the work proposed would duplicate some of the Deakin University study if the two agencies did not share data, resources and expertises.

7. Preliminary FRDC application. “Yield, egg and value per recruit and thermal model validation for the giant crab fishery of Southern Australia.” By Deakin University, 1999

This pre-proposal is basically the next stage in research following the previous 6 years of work by Deakin University. In general it seeks to add more detail to the information already gathered about the animal and its fishery. Such detail can be placed in the “nice to know” category if sufficient funds were available, but is not as pressing (at this particular time) as the information that would be obtained from the TAFI proposal. That is, the Deakin proposal falls short in demonstrating that it will provide focused information for a model designed to adjust TACCs.

8. SPIRT Grant application for year 2000 grants. “Ageing giant crabs by two novel techniques - radioisotope ratios and lipofuscin fraction”. University of Tasmania and TAFI.

This is an excellent proposal that was successful. I was shown the project in Hobart and it is apparently yielding very promising results which should lead to the confident ageing of giant crabs. This information will be very useful in any future modelling work. As mentioned earlier, FRDC would be wise to wait for this project to be completed and for its ageing



information to be used by TAFI modellers, in addition to the Deakin University data, before funding any future research in this fishery.

9. Giant crab research proposal notes. Caleb Gardner's notes for the preparation of a new FRDC application, 2000.

These notes from Caleb Gardener are sound and again indicate the high priority that TAFI apportion to an industry-focused data-collection regime. Again, one cannot help but think that using anyone other than Mr. Levings in such work would lead to unnecessary duplication.