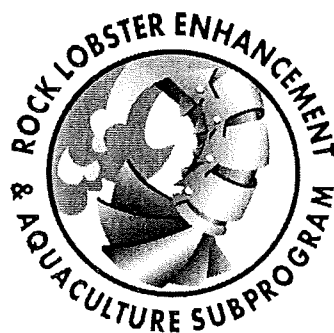


Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram

Dr Robert van Barneveld
Principal Investigator



Project No. 1998/301

98/301: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.

Principal Investigator

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1998/301: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS)

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OBJECTIVES:

1. Coordinate the FRDC Rock Lobster Enhancement and Aquaculture Subprogram (applications, workshops, communication).
2. Conduct an annual research workshop to present research outcomes from the subprogram and to define research objectives for subsequent years.
3. Facilitate travel of the subprogram project Principal Investigators, a nominated industry representative and the Subprogram Leader to biannual scientific meetings.
4. Facilitate travel of industry representatives and the Subprogram Leader to biannual Steering/Management Committee meetings.
5. Coordinate the preparation of a subprogram newsletter, media releases and workshop publications.
6. Integrate with other FRDC and externally funded rock lobster research programs (eg FRDC Project 98/300 – Propagation of rock lobster – development of a collaborative national project with international partners and the FRDC Rock Lobster Post-Harvest Subprogram).

NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED

The purpose of the RLEAS was to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive while operating in harmony with the wild fisheries. The Subprogram evolved from being actively opposed by the wild fishing sector in many states, to being an integral part in the future development of the rock lobster sector. A degree of harmony was established between the wild fishery and the aquaculture sector, and a high degree of research coordination has been established between states and internationally with researchers in New Zealand and Japan. None of this would have been possible without an independent Subprogram Leader and a highly responsive Steering Committee that is strongly represented by industry members from across Australia.

The presence of a coordination component within the RLEAS has resulted in savings in the operation of new and existing projects far exceeding \$500,000 and it is likely that this trend will exist in the future. In addition, since 1998 the RLEAS has delivered outcomes from 4 core projects with outcomes pending from another four projects in June, 2000. In April 2000, the FRDC funded an additional 5 projects within the Subprogram that will run concurrently until June, 2003. It is unlikely that this level of highly focussed research and productivity would have been possible without a coordinated subprogram.

Subprogram mission and content

Immediately after establishment, the Rock Lobster Aquaculture Subprogram responded to industry feedback and renamed the subprogram to the “Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS)”. The mission for the RLEAS was revised to the following:

“To provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries”.

“Enhancement” was being used to describe processes that could improve the market value of an adult rock lobster collected from the wild (under existing guidelines) usually through supplementary feeding in sea-based cages or land-based tanks. Enhancement was also being used to describe the potential for aquaculture systems to produce additional puerulus or juveniles for use in reseeding programs for the wild fishery. “Aquaculture” described the rearing of rock lobster from eggs to a marketable size in an intensive culture system or the on-growing of juvenile lobsters to a marketable size in intensive culture systems.

At the time of establishment, the RLEAS consisted of 6 core projects:

98/300: Propagation of rock lobster – development of a collaborative national project with international partners. Principal Investigator: Dr Piers Hart (Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

98/301: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram. Principal Investigator: Dr Robert van Barneveld (Barneveld Nutrition Pty Ltd, PO Box 42, Lyndoch, SA, 5351)

98/302: Towards establishing techniques for large-scale harvesting of pueruli and obtaining a better understanding of mortality rates. Principal Investigator: Dr Bruce Phillips (Fisheries WA, WA Marine Research Laboratories, PO Box 20, North Beach, WA, 6020)

98/303: Feed development for rock lobster aquaculture. Principal Investigator: Dr Kevin Williams (CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages. Principal Investigator: Assoc Prof Louis Evans (Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out. Principal Investigator: Assoc Prof Mike Geddes (University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

During the course 98/301, an additional two projects were approved by the FRDC Board, including:

99/314: Preliminary investigation towards on-growing puerulus to enhance rock lobster stocks while providing animals for commercial culture. Principal Investigator: Dr Caleb Gardner (Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

99/315: Propagation techniques. Principal Investigator: Dr Piers Hart (Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Subprogram management and operating procedures

The RLEAS was highly responsive to the views of industry and understood the need to accommodate both the research requirements of the future and the needs of the existing wild fisheries and aquaculture industries. To ensure that research conducted within the Subprogram was relevant and met the above criteria, a Steering Committee was established to:

1. Provide industry feedback and views;
2. Review existing research based on FRDC contractual obligations;
3. Prioritise new proposals and provide a priority list for other agencies;

4. Ensure outcomes are commercially focussed;
5. Coordinate industry and research provider involvement - optimum use of resources;
6. Facilitate extension and technology transfer.

Scientific and Steering Committee meetings

A total of three scientific committee meetings were convened between 1998 and 1999. The meetings were discontinued in preference to direct discussions between the Steering Committee and the principal investigators. Six Steering Committee meetings were held between July, 1998 and June, 2001. All meetings were minuted and actioned. Detailed copies of the minutes have not been included in this report for the sake of brevity and the confidential nature of some of the discussions.

Subprogram workshops

A preliminary planning workshop was convened with all potential subprogram participants and a series of applications were coordinated and submitted to FRDC. All projects were funded and the Subprogram commenced in July, 1998. The first annual workshop was held in Geraldton on March 11, 1999. More than 50 people attended representing scientists, rock lobster fishers and aquaculturalists. A full set of proceedings resulted from this workshop. The second annual RLEAS workshop was convened in Hobart in February, 2000 attracting more than 40 participants from Australia and New Zealand. The third annual workshop was convened in New Zealand in conjunction with the New Zealand Rock Lobster Industry Council between April 2 and 7, 2001. A full set of proceedings was produced from this workshop.

Communications

Subprogram newsletters were used as a primary form of communication between the Subprogram and industry.

Annual Operating Plans

Three annual operating plans for the RLEAS were prepared over the course of this project. Copies of the annual operating plans have been included in this report (see Appendix 6).

Priority setting and new research projects

Detailed work commenced on a strategic plan for the subprogram. This included a visit to research institutions in New Zealand in an attempt to establish collaborative links with groups that are arguably more advanced in rock lobster aquaculture research than we are in Australia. The Steering Committee was successful in establishing research priorities for the subprogram and an indicative budget allocation for 2000 onwards.

Collaboration and additional funding opportunities

Additional funding opportunities were investigated for the Subprogram. Avenues for funding include COMET grants through AUSIndustry in conjunction with Ferguson Fisheries (who were successfully funded), the Public Good Science Fund in New Zealand using existing funding from the RLEAS being expended in New Zealand as leverage and NIWA travel grants to promote interaction between scientists in Australia and New Zealand.

KEYWORDS: Rock lobster, aquaculture,

BACKGROUND

There was, and still is, growing interest in Australia in the commercial potential for on-growing and culture of rock lobster. A major development initiative was being implemented in Tasmania in 1998 and similar plans were being developed for the same, and other, species of rock lobster in other Australian states. There was also international interest in these developments with active research groups in New Zealand and Japan.

There are a number of critical issues to be overcome if rock lobster growing and culture is to be commercially viable and acceptable in terms of their impact on the sustainability of the natural resource. Resolving these issues will require extensive research and development and a multi-disciplinary approach involving a number of research organisations.

The Fisheries Research and Development Corporation had funded a number of workshops aimed at establishing priorities for rock lobster research in Australia. It was generally agreed that the following principles were desirable in the submitted projects:

- A guarantee of biological neutrality for the wild population;
- A national focus (results should be transferable between species and regions).
- Industry focus;
- Should not undermine any current business advantage;
- Should address barriers to development that are a result of market failure.

In addition to this, the final complexion of the program of research should reflect the spread of interest around Australia (in terms of species, industries and research providers). The need to ensure biological neutrality and hence no impact on the sustainability of current industries was also recognised as a fundamental principle.

In a research priority setting exercise, delegates of the above FRDC workshops were asked to rate relevant research areas using a complex blend of timeliness, feasibility and attractiveness – it was recognised that emphasis was being put on short term or immediate issues. The following research priorities (in order of priority) were identified through this ranking process:

1. Puerulus grow-out (255): Major issues: Collection and neutrality (410), husbandry (190).
2. Adult holding (150): Husbandry (600).
3. Economics and marketing (110): Market economics (315), Production economics (285)
4. Propagation (85): Larval husbandry (355), egg production (210), genetics (35).

The major emphasis in terms of broad research goals was on puerulus grow-out. It was noted that this reflected the timing of current priorities and that as more knowledge developed the priorities would change with more emphasis falling onto closing the life cycle. It was recognised that in the longer term this was a high priority.

Based on the above research priorities, a total of six research project submissions were presented to the FRDC in the 1998/99 funding round from six different research organisations. A comparison between the research objectives of these projects and the research priorities established above revealed considerable overlap between projects and a number of research gaps. In particular, gaps were identified in the high priority areas of puerulus nutrition and environmental manipulation, system design and handling associated with husbandry in adult holding systems, and the study of international markets and impacts of changes on existing markets under economics and marketing. Significant overlaps were identified in the areas of nutrition, health and handling of adult rock lobsters and health of juveniles.

In response to the research funding submissions and perceived research gaps and overlaps, the FRDC Board, which met in March 1998 requested that a workshop be convened with the objective of

exploring the need for a subprogram. The Board agreed to an indicative budget of \$1.5 million over three years to cover the scope of the research and development presented in the original applications. The Board also approved project "98/300 – Propagation of rock lobster – development of a collaborative national project with international partners" subject to specific conditions. The workshop was convened in Adelaide on March 19, 1998. It endorsed the formation of a subprogram and assigned a total budget of \$1,210,367.40. The participants recognised the needs for flexibility in years 2 and 3 in keeping with the subprogram format and agreed to hold \$289,632.60 in contingency. The workshop also agreed that there would be an application on propagation in the next funding round (1999/00) following the international workshop convened as part of project 98/300.

Subprogram Mission, Vision and Goals

At the time of the subprogram's establishment, the following mission, vision and goals were envisaged:

Mission

To research, promote and develop a sustainable rock lobster aquaculture industry in Australia.

Vision

To provide timely research and development outcomes that result in the best and most competitive rock lobster aquaculture industry in the world.

Goals

1. Involve industry in all facets of research and development and ensure adoption of the outcomes.
2. Develop research outcomes that result in increased profitability and reduced risk for the Australian rock lobster aquaculture industry.
3. To empower industry to be actively responsible for its own research and development.
4. To develop a communication strategy that delivers results in a timely and readily useable form.

Subprogram components

At the commencement of the subprogram, it had the following component projects:

A planning meeting was held in South Australia in March, 1998 to discuss subprogram objectives and to develop a set of coordinated research applications. The following research projects were defined and form the basis of the sub-program:

98/300: Propagation of rock lobster – development of a collaborative national project with international partners

Principal Investigator: Dr Piers Hart
(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Taroona, TAS, 7053)

Project Objectives:

1. Identify potential for the development of commercial culture of rock lobster in Australia and determine the research and development potential required to achieve this potential.
2. Identify what resources (expertise, facilities, funds) are required to conduct the necessary research and development.

3. Identify potential international and national research and industry partners who are interested in collaborative research into culture of rock lobster from eggs.
4. Develop a research plan mapping out research and development projects, the collaborative partners, timelines and resources.
5. Submit a proposal to FRDC under the rock lobster enhancement and aquaculture subprogram.

98/301: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.

Principal Investigator: Dr Robert van Barneveld
(Barneveld Nutrition Pty Ltd, PO Box 42, Lyndoch, SA, 5351)

Project Objectives:

1. Coordinate the FRDC Rock Lobster Enhancement and Aquaculture Subprogram (applications, workshops, communication).
2. Conduct an annual research workshop to present research outcomes from the subprogram and to define research objectives for subsequent years.
3. Facilitate travel of the subprogram project Principal Investigators, a nominated industry representative and the Subprogram Leader to biannual scientific meetings.
4. Facilitate travel of industry representatives and the Subprogram Leader to biannual Steering and Management Committee meetings.
5. Coordinate the preparation of a subprogram newsletter, media releases and workshop publications.
6. Integrate with other FRDC and externally funded rock lobster research programs (eg FRDC Project 98/300 – Propagation of rock lobster – development of a collaborative national project with international partners and the FRDC Rock Lobster Post-Harvest Subprogram).

98/302: Towards establishing techniques for large-scale harvesting of pueruli and obtaining a better understanding of mortality rates

Principal Investigator: Dr Bruce Phillips
(Fisheries WA, WA Marine Research Laboratories, PO Box 20, North Beach, WA, 6020)

Project Objectives (Revised June, 1999):

1. To determine appropriate puerulus to legal size survival rates and potential harvesting ratios, that if implemented in the western rock lobster fishery, might result in “biological neutrality” being achieved.
2. To establish techniques for large scale harvesting of pueruli for rock lobsters.
3. To collaborate with scientists conducting puerulus collection research in Tasmania.

98/303: Feed development for rock lobster aquaculture

Principal Investigator: Dr Kevin Williams
(CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

Project Objectives:

1. Review the state of knowledge of crustacean and fish nutrition of relevance to the development of formulated feeds for rock lobsters.
2. Develop a ‘best guess’ formulated diet for juvenile and adult rock lobsters (for tropical, *Panulirus ornatus*, western, *P. cygnus* and southern, *Jasus edwardsii* species) for comparative trialing against existing ‘fresh’ diet.
3. Determine the response of post-pueruli/juveniles and adult rock lobsters to key nutrients critical for the development of cost-effective formulated diets for rock lobsters.
4. Make recommendations on the direction of future nutrition research.

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages

Principal Investigator: Assoc Prof Louis Evans
(Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

Project Objectives:

1. To establish a national network of rock lobster health and disease personnel.
2. To conduct a symposium on health and disease management in lobster aquaculture and long-term holding facilities
3. To collate and document current state of knowledge on rock lobster diseases.
4. To provide a disease diagnosis service for existing FRDC rock lobster projects in Queensland, South Australia and Western Australia.

98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out

Principal Investigator: Assoc Prof Mike Geddes
(University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

Project Objectives:

1. Assess the interactions between stocking density and feed delivery system on maintaining and improving condition and on the growth performance of adult rock lobsters in existing sea-based holding systems in different seasons.
2. Determine the effects of temperature, salinity and photoperiod on the growth rate and survival of juvenile rock lobsters in existing land-based holding systems.
3. Determine the effects of stocking density and shelter on the growth rate and survival of juvenile rock lobsters in existing land-based holding systems.
4. Evaluate existing system design and management regimes for land-based captive grow out of juvenile rock lobsters and for sea-based holding of adult rock lobsters.

NEED

The need for a coordinated subprogram, and research projects focussing on collection and neutrality, nutrition, health and system design and handling was outlined in the background. Further evidence of the need for this and the other subprogram projects includes:

Project 1: Coordination and subprogram management: At a planning workshop in Hobart in 1997, an open forum of all participants identified 21 issues of concern to the aquaculture of rock lobsters. These were condensed into five major issues with each major issues condensed examined in detail by a discussion group. One of the five major issues was project management. Based on the range of research issues and other programs related to rock lobsters, well facilitated project management was considered a fundamental priority. With increasing demands being placed on scientists by their host organisations, the role of Sub-program Leader in addition to project commitments can be impossible to fulfil adequately. A dedicated Sub-program Leader will ensure the Sub-program runs effectively and objectives are delivered on time to the industry.

Project 2: Collection and neutrality: Before any large scale commercial on-growing of postlarvae is permitted, it will be necessary to establish what effect large scale harvesting of pueruli might have on the wild stock. A second critical need to the success of any commercial venture into rock lobster postlarval growout is that techniques be developed to harvest huge quantities of healthy pueruli. Research is needed to estimate the likely impact of large-scale harvesting of puerulus on the commercial fishery and to establish methods and equipment necessary to catch large quantities of pueruli in the most cost-effective way.

Project 3: Nutrition: In Australia, opportunities to value add to the wild catch of lobsters or to on-grow juveniles taken from the wild is seriously constrained by the lack of a cost-effective and efficacious rock lobster feed. This contrasts with the developing industry in New Zealand where waste from the large mussel industry is an available and inexpensive source of feed. If feed comprises 40-50% of rock lobster production costs as is the case in other aquaculture industries (prawns, finfish), the development of a suitable manufactured feed is crucial for the successful establishment of rock lobster aquaculture in Australia.

Project 4: Health: Due to the infancy of rock lobster aquaculture, disease conditions associated with production are poorly understood. Similarly, the prevalence of disease conditions in wildstock and their likely impact in aquaculture systems or extended holding systems has yet to be determined. While other factors associated with the establishment of rock lobster aquaculture are perceived as a higher priority, it is recognised that health monitoring and the early identification of diseases that may affect production is critical. In the short term, there is a need to establish a mechanism for the monitoring of disease conditions of juvenile and adult lobsters in land-based and sea-based holding systems. This will not only provide industry with a means of assessment of moribund lobsters, but will facilitate the identification of health research priorities.

Project 5: System design and handling: Rock lobster fisheries throughout the world are generally fully or over-exploited while market demand remains very high with this product positioned at the premium end of the crustacean market spectrum. The proposed research will assist in increasing supply of this valuable product in a sustainable way and will consequently decrease pressure on wild populations. System design and basic husbandry information must be completed in conjunction with health and nutrition research as these factors combine to influence the efficiency of production.

OBJECTIVES

1. Coordinate the FRDC Rock Lobster Enhancement and Aquaculture Subprogram (applications, workshops, communication).
2. Conduct an annual research workshop to present research outcomes from the subprogram and to define research objectives for subsequent years.
3. Facilitate travel of the subprogram project Principal Investigators, a nominated industry representative and the Subprogram Leader to biannual scientific meetings.
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6. Integrate with other FRDC and externally funded rock lobster research programs (eg FRDC Project 98/300 – Propagation of rock lobster – development of a collaborative national project with international partners and the FRDC Rock Lobster Post-Harvest Subprogram).

GENERAL METHODS

Industry consultation and communication

The Subprogram Leader promoted the activities of the RLEAS through industry newsletters and direct communication with industry organisations and representatives. Heavy reliance was placed upon ongoing maintenance of the Steering Committee with representatives from the rock lobster wild fishing sectors and the aquaculture sectors across Australia for the provision of strategic direction and advice.

Strategic planning

Strategic planning for the RLEAS was based on outcomes from the initial research program and ongoing consultation between the Subprogram Leader and members of industry and researchers in Australia and New Zealand. The strategic planning process identified those factors that represented restrictions to the initial establishment of rock lobster aquaculture (eg. propagation, nutrition) and enhancement (eg. monitoring survival, prevention of disease introduction to the wild fishery) processes, and then utilised a relative ranking score from the various rock lobster fisheries across Australia.

Communication with FRABs

Communication with FRAB's was via distribution of an annual operating plan for the RLEAS in December of each year combined with direct communications. The Subprogram Leader also attended the annual FRDC FRAB workshop to promote the activities and objectives of the RLEAS.

Development of new research proposals

New research proposals were developed through the use of facilitated strategic planning meetings. The Subprogram Leader convened meetings with relevant researchers and research institutions to:

1. Define the planned outcomes of the new proposal;
2. Manage an indicative budget for the research as defined by the Steering Committee;
3. Identify which researchers/institutions are best placed to undertake the research;
4. Promote collaboration between researchers and institutions where appropriate;
5. Seek external expertise and inputs as required.
6. Ensure the new proposal meets the objectives of the subprogram and that the research remains relevant and focussed.

The Subprogram Leader ensured new research proposals were distributed to FRABS and the RLEAS Steering Committee for comment and ratification before submitting the proposals to FRDC on behalf of the lead agencies, or facilitating adjustments to the proposals prior to submission.

Coordination of research reports

The Subprogram Leader collated progress and final reports from projects within the Subprogram in March and September each year for delivery in a common format to FRDC. These reports were distributed to members of the Steering Committee for comment and review.

Review of research progress and direction

The RLEAS Steering Committee interviewed Principal Investigators of each project within the Subprogram twice annually as part of the Steering Committee meetings. Principal Investigators were expected to report progress against contracted milestones, justify any changes in research direction,

and demonstrate the research program was making a valuable contribution towards the achievement of the subprogram objectives. The Steering Committee made recommendations to the FRDC Board in relation to potential changes to the objectives of the research program, or instances where project progress is unsatisfactory.

Coordination of research extension

A major function of the Subprogram Leader was the organisation and delivery of an annual research workshop to highlight the activities and outputs of the RLEAS. Workshops were convened with presentations from invited speakers and researchers aimed at delivering key messages to end-users for use in practical rock lobster aquaculture and enhancement systems.

The Subprogram Leader compiled a subprogram newsletter "Lob ReLEASE" at least annually or as required highlighting research outcomes, developments in rock lobster enhancement and aquaculture and events relevant to the RLEAS. The Subprogram Leader was also responsible for the approval of all media releases and scientific publications arising from research projects within the Subprogram using the RLEAS Steering Committee communication policy as a guide.

Collaboration with international partners

The Subprogram Leader established a major international collaboration between researchers in Australia and New Zealand through project 98/301. This was achieved through direct interaction with researchers in New Zealand and involvement of these scientists in the RLEAS research program.

Liaison with FRDC

The Subprogram Leader was the conduit for communications between FRDC and subprogram participants in relation to project contracts, project reports, new submissions and general correspondence. The Subprogram Leader also represented the RLEAS at the annual FRDC FRAB and Subprogram meetings in Canberra.

RESULTS/DISCUSSION

Subprogram mission and content

Immediately after establishment, the Rock Lobster Aquaculture Subprogram responded to industry feedback and renamed the subprogram to the "Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS)". The mission for the RLEAS was revised to the following:

"To provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries".

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At the time of establishment, the RLEAS consisted of 6 core projects:

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99/315: Propagation techniques. Principal Investigator: Dr Piers Hart (Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Subprogram identity

The RLEAS logo and the “Lob ReLEASE” banner was developed as part of project 98/301:



Subprogram management and operating procedures

The RLEAS was highly responsive to the views of industry and understood the need to accommodate both the research requirements of the future and the needs of the existing wild fisheries and aquaculture industries. To ensure that research conducted within the Subprogram was relevant and met the above criteria, a Steering Committee was established to:

1. Provide industry feedback and views;
2. Review existing research based on FRDC contractual obligations;
3. Prioritise new proposals and provide a priority list for other agencies;
4. Ensure outcomes are commercially focussed;
5. Coordinate industry and research provider involvement - optimum use of resources;
6. Facilitate extension and technology transfer.

Through the conduct of 98/301, industry bodies and FRAB's were contacted in 1998 seeking nominations for the RLEAS Steering Committee. After a selection process membership of the Steering Committee included Robert van Barneveld (Chair), Patrick Hone (FRDC), Pheroze Jungalwalla (TAS), Neil Stump (TAS), Lionel Carrison (SA), Greg Ward (SA), Barry Spurrier (VIC), David Lucas (VIC), Jim Fogarty (QLD), Ian Finlay (WA), John Newby (WA), Peter Auguston (WA) and Bruce Phillips (FRDC Rock Lobster Post-Harvest Subprogram Leader).

The Steering Committee met in March and September each year to review project progress and establish research priorities. Advice from the September Steering Committee meetings was sent to all Fisheries Research Advisory Bodies so that they were aware of the subprogram research priorities. All new projects relating to rock lobster enhancement and aquaculture were assessed by the Steering Committee and were submitted to the FRDC Board via the subprogram. An annual subprogram workshop was held each March to extend research results to industry and researchers.

In addition to the RLEAS Steering Committee, a Scientific Committee was established to:

- To conduct scientific reviews of all projects; ensuring that research to be undertaken is achievable;
- To ensure scientific objectives are met;
- To foster and develop collaboration;
- To coordinate new funding applications.

The Scientific Committee initially reported to the Steering Committee through the Subprogram Leader.

The participants of the Scientific Committee consisted of the Subprogram Leader, Principal Investigators of the subprogram component projects and direct industry collaborators (as required). Tenure was dependent on the funding term for a particular project. The Scientific Committee met biannually, and if possible, the meetings were held to coincide with other events to minimise travel costs. An annual research workshop ensured that research results and project progress was disseminated to a wider audience and that all members of the rock lobster aquaculture industry and other interested parties could benefit from the research.

After three Scientific Committee meetings, it was deemed more appropriate for the principal investigators to communicate directly with the Steering Committee via interviews at the Steering Committee meetings and to only hold informal meetings on scientific content of the projects.

Scientific and Steering Committee meetings

A total of three scientific committee meetings were convened between 1998 and 1999. The meetings were discontinued in preference to direct discussions between the Steering Committee and the principal investigators.

Six Steering Committee meetings were held between July, 1998 and June, 2001. All meetings were minuted and actioned. Detailed copies of the minutes have not been included in this report for the sake of brevity and the confidential nature of some of the discussions.

Subprogram workshops

A preliminary planning workshop was convened with all potential subprogram participants and a series of applications were coordinated and submitted to FRDC. All projects were funded and the Subprogram commenced in July, 1998.

The first annual workshop was held in Geraldton on March 11, 1999. More than 50 people attended representing scientists, rock lobster fishers and aquaculturalists. A full set of proceedings resulted from this workshop.

The second annual RLEAS workshop was convened in Hobart in February, 2000 attracting more than 40 participants from Australia and New Zealand. Active discussion of approaches to puerulus collection for aquaculture ensued following a presentation from Mr Peter Shelley who was the Chairman of the Tasmanian Rock Lobster Grower's Association.

The third annual workshop was been convened in New Zealand in conjunction with the New Zealand Rock Lobster Industry Council between April 2 and 7, 2001. A full set of proceedings was produced from this workshop.

A full list of publications arising from workshops is contained in Appendix 3.

Communications

The RLEAS Steering Committee facilitated the orderly release of information produced by, and meeting the needs of, Subprogram participants.

All media releases, publications and presentations produced as a result of Subprogram activities were vetted by the RLEAS Steering Committee and required a minimum of 5 working days for review.

Communications Subcommittee Assessment Criteria:

- Appropriate format is used to ensure that it is understandable by the targeted audience
- Contains no errors of fact
- Grammatically correct
- Appropriate acknowledgments given
 - FRDC
 - CRC for Aquaculture
 - other relevant bodies
 - relevant personnel
- Meets contractual and intellectual property agreements
- Wording is politically correct

Subprogram Newsletter:

- “Lob ReLEASE” was edited by the Subprogram Leader before circulation to the Steering Committee for review.

Workshop Proceedings:

- Researchers supplied a disk copy of presentations from the workshop as well as more comprehensive supplementary documentation to include in the proceedings within 2 weeks of the workshop.

Scientific Publications:

- Were developed with the input of all appropriate co-authors
- Were submitted through the normal publications review channels of the institution of the primary author
- Were then provided to the Subprogram Leader who distributed it to the Steering Committee for comment.

Subprogram media releases:

- ALL media releases should have been sent to the Subprogram Leader via e-mail for review and distribution to the Steering Committee
- Once reviewed by the Steering Committee any suggested editing were forwarded to the Subprogram Leader for collation
- All editing was then forwarded to the author for preparation of a final draft
- The final draft was recirculated by the Subprogram Leader to the Steering Committee for approval.

- A proof of ALL print media MUST have been sighted by the Subprogram Leader prior to release. If the media outlet was not prepared to release the proof of the text, then approval will not be granted for publication.
- A transcript of ALL radio and television interviews MUST be viewed or heard by the Subprogram Leader prior to release. If the media outlet is not prepared to release a transcript, then approval will not be granted for release.

Unsolicited Media Enquiries/Interviews:

- Where possible arrange an appropriate future time to discuss the topic so that a brief note can be circulated via e-mail to the Steering Committee detailing;
 - Who the media contact is and what organisation they represent
 - The topic to be covered
 - Details of what issues will be discussed
 - A feedback deadline for the Communications Subcommittee response to your note
- Discussion should be restricted to research you have or are conducting (refer to appropriate scientist if required) not issues of a policy or political nature
- Upon completion of the interview a brief summary of what transpired should be sent to the Subprogram Leader
- It should be noted that planned media releases are the preferred option whenever possible.

Subprogram Conference Presentations:

- The conference presentation abstract should be sent to the Subprogram Leader via e-mail for review and distribution to the Steering Committee
- The final conference presentation should have been sent to the Subprogram Leader via e-mail for review and distribution to the Steering Committee
- The final conference paper should have been sent to the Subprogram Leader via e-mail for review and distribution to the Steering Committee
- All conference presentations should have used the standardised Subprogram presentation format.

These guidelines applied to research relevant to the RLEAS being conducted in Australia and New Zealand. If these guidelines were not adhered to strictly, then the RLEAS would not provide any support for repercussions that may have arisen as a result of a public release of information.

Copies of the newsletter prepared during the course of this project have been included in Appendix 4.

Additional publications are presented in Appendix 5.

Annual Operating Plans

Three annual operating plans for the RLEAS were prepared over the course of this project. Copies of the annual operating plans have been included in this report (see Appendix 6).

Priority setting and new research projects

Detailed work commenced on a strategic plan for the subprogram. This included a visit to research institutions in New Zealand in an attempt to establish collaborative links with groups that are arguably more advanced in rock lobster aquaculture research than we are in Australia. The Steering Committee was successful in establishing research priorities for the subprogram and an indicative budget allocation for 2000 onwards. Based on research completed to that point, and trends in the emergence of rock lobster aquaculture activities in Australia and New Zealand, the RLEAS Steering Committee identified the following outcomes as critical to the success of the Subprogram beyond the year 2000:

1. Propagation: The ability to produce puerulus from eggs from captive broodstock on a commercially viable scale with a focus on *P.ornatus* and *J.edwardsii*.
2. Live-holding/grow-out: Identification of the factors that influence tail fan necrosis in *J. edwardsii* for juveniles and adults and whether these factors can be influenced in a management context with a research focus on prevention management.

Based on these priorities and indicative budget allocations, the RLEAS Steering Committee sought key applications in the areas of:

1. Broodstock and culture of rock lobsters;
2. Live-holding and grow-out of rock lobsters;
3. Economics and marketing considerations for rock lobster products produced from aquaculture and the potential impacts on the wild sector.

Using project 98/301 to facilitate the development of project applications, a number of new projects were subsequently approved by the FRDC Board in the 2000/2001 funding round. A large collaborative project between the Tasmanian Aquaculture and Fisheries Institute (TAFI), CSIRO Marine Science, and the National Institute of Water and Atmospheric (NIWA) Research in New Zealand will investigate ways to improve our capacity to propagate rock lobsters from eggs to puerulus in a commercially viable time frame. Another project involving CSIRO Marine Science, NIWA, TAFI and the University of Adelaide will examine the nutrition of juveniles in their first year of development. Dr Mike Hall from AIMS in Townsville will investigate the hormonal manipulation of rock lobster larval phases in an attempt to shorten the length of the larval phases while Dr Caleb Gardner from TAFI will continue to investigate the survival of aquaculture reared juveniles when released back to the wild. Tail fan damage will be investigated by the University of Adelaide and the South Australian Research and Development Institute.

Collaboration and additional funding opportunities

Additional funding opportunities were investigated for the Subprogram. Avenues for funding include COMET grants through AUSIndustry in conjunction with Ferguson Fisheries (who were successfully funded), the Public Good Science Fund in New Zealand using existing funding from the RLEAS being expended in New Zealand as leverage and NIWA travel grants to promote interaction between scientists in Australia and New Zealand.

BENEFITS

Research relevance and acceptance

The purpose of the RLEAS was to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive while operating in harmony with the wild fisheries. The Subprogram has evolved from being actively opposed by the wild fishing sector in many states, to being an integral part in the future development of the rock lobster sector. A degree of harmony has been established between the wild fishery and the aquaculture sector, and a high degree of research coordination has been established between states and internationally with researchers in New Zealand and Japan. None of this would have been possible without an independent Subprogram Leader and a highly responsive Steering Committee that is strongly represented by industry members from across Australia.

Research efficiency and output

The presence of a coordination component within the RLEAS has resulted in savings in the operation of new and existing projects far exceeding \$500,000 and it is likely that this trend will exist in the future. In addition, since 1998 the RLEAS has delivered outcomes from 4 core projects with outcomes pending from another four projects in June, 2000. In April 2000, the FRDC funded an additional 5 projects within the Subprogram that will run concurrently until June, 2003. It is unlikely that this level of highly focussed research and productivity would have been possible without a coordinated subprogram.

In the past, the establishment of subprograms has resulted in considerable savings in travel and operating expenditure by centralising expenditure for workshops, publications and extension within a coordination project.

FURTHER DEVELOPMENT

As a result of this project, a further submission was made to FRDC for continuation of the RLEAS. This project was funded and will be on-going until June, 2004.

PLANNED OUTCOMES

The purpose of the RLEAS was to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive while operating in harmony with the wild fisheries. The Subprogram evolved from being actively opposed by the wild fishing sector in many states, to being an integral part in the future development of the rock lobster sector. A degree of harmony was established between the wild fishery and the aquaculture sector, and a high degree of research coordination has been established between states and internationally with researchers in New Zealand and Japan. None of this would have been possible without an independent Subprogram Leader and a highly responsive Steering Committee that is strongly represented by industry members from across Australia.

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CONCLUSION

The RLEAS developed into a highly coordinated research program with core projects focussing on key limitations to the establishment of rock lobster and enhancement and aquaculture systems in Australia. Through a research subprogram, representatives of the wild fishing sector and aquaculture enterprises have contributed to the strategic planning for this research program. The establishment of the subprogram allowed the development of research projects addressing complex issues such as rock lobster propagation that would not have been possible within a single research institution. To this end, the subprogram (and other subprograms) can successfully address aspects of 'market failure' in research programs through coordinated research efforts.

APPENDIX 1 – Intellectual Property

There is no intellectual property arising from this project.

APPENDIX 2 - Staff

Dr Robert van Barneveld, Barneveld Nutrition Pty Ltd, 19-27 Coonan Rd, South Maclean, Qld, 4280.
Ph: (07) 5547 8611. Fax: (07) 5547 8624. E-mail: rob@barneveld.com.au.

Appendix 3 – Workshop Publications

Rock Lobster Enhancement and Aquaculture Subprogram



Publications Order Form

Name	
Postal Address	
Contact Phone Number	
Payment Method	<input type="checkbox"/> Cheque (encl) <input type="checkbox"/> EFT (bank account details provided upon confirmation of order)

Publication	Cost	Quantity	Subtotal
<input type="checkbox"/> RLEAS Publication No.1 Rock Lobster Health Workshop: Current Status, Future Directions and Research and Development Priorities Compiled by Assoc Prof Louis Evans, June 1998	\$11.00		
<input type="checkbox"/> RLEAS Publication No.2 International Symposium on Lobster Health Management Compiled by Assoc Prof Louis Evans, September 1999	\$22.00		
<input type="checkbox"/> RLEAS Publication No.3 Technical Potential for Rock Lobster Propagation in Aquaculture Systems Edited by Dr Piers R Hart and Dr Robert van Barneveld, August 2000	\$22.00		
<input type="checkbox"/> RLEAS Publication No.4 Developments in Rock Lobster Enhancement and Aquaculture I (RLEAS Workshop 1999) Edited by Dr Robert van Barneveld, March 1999	\$22.00		
<input type="checkbox"/> RLEAS Publication No.5 Developments in Rock Lobster Enhancement and Aquaculture II (RLEAS Workshop 2000) Edited by Dr Robert van Barneveld, April 2000	\$22.00		
<input type="checkbox"/> RLEAS Publication No.6 Developments in Rock Lobster Enhancements and Aquaculture III (RLEAS Workshop 2001) Edited by Dr Robert van Barneveld, April 2001	\$22.00		
<input type="checkbox"/> RLEAS Publication No.7 Developments in Rock Lobster Enhancements, Aquaculture and Post Harvest Practices IIII (RLEAS Workshop 2002) Edited by Dr Robert van Barneveld & Dr Bruce Phillips, June 2002	\$22.00		
<input type="checkbox"/> RLEAS FRDC Final Report – FRDC Project No. 1999/315 The Development of Rock Lobster Propagation Techniques for Aquaculture in Australia Bradley Crear & Piers Hart, August 2001	\$22.00		

Please Note: All prices are in Australian Dollars, overseas orders will attract additional postage charges

Sub Total \$ _____

+ Postage and Handling \$ 8.00

TOTAL \$ _____

* All prices are GST inclusive, a tax invoice will be issued upon receipt of payment.

Please return this order form for processing via the following:

Facsimile : 07 5547 8624 or

Post: Barneveld Nutrition Pty Ltd
19-27 Coonan Rd,
South Maclean Qld 4280

acn 081 190 098

For enquiries please call: 07 5547 8611



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Appendix 4 – Newsletters



Lob ReLEASE

Volume 1, Issue 1
August 1999

DEVELOPMENTS IN ROCK LOBSTER ENHANCEMENT AND AQUACULTURE RESEARCH

From the Subprogram Leader...

"Lob ReLEASE" is published as the principal industry communication of the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) which is coordinated by the Fisheries R&D Corporation. It will initially be published every 6 months to provide information to members of the Australian rock lobster industries on developments in rock lobster enhancement and aquaculture research.



As a starting point, I thought it would be useful to explain what is meant by the terms "enhancement" and "aquaculture" in the context of this Subprogram and this newsletter. "Enhancement" is being used to describe processes that could improve the market value of an adult rock lobster collected from the wild (under existing guidelines) usually through supplementary feeding in sea-based cages or land-based tanks. Enhancement is also being used to describe the potential for aquaculture systems to produce additional puerulus or juveniles for use in reseeded programs for the wild fishery. "Aquaculture" describes the rearing of rock lobster from eggs to a marketable size in an intensive culture system or the on-growing of juvenile lobsters to a marketable size in intensive culture systems.

In this first issue of Lob ReLEASE we will outline the research projects within the existing Subprogram, discuss how research priorities and research within the Subprogram is monitored, deliver some recent research results and we will highlight some coming events and new publications arising from the research. If you would like more information on the Subprogram or wish to get involved in any aspect of the research, feel free to contact me on 08 85 246 477 or 0418 802 462.

Dr Robert van Barneveld
RLEAS Leader

About the Rock Lobster Enhancement and Aquaculture Subprogram...

The Fisheries Research and Development Corporation established the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) in July, 1998 following consultation with industry and scientists. The Subprogram was established with the following objective or "mission":

"To provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries".

RLEAS has a total of 8 base projects at present with a number seeking renewal in 2000/2001 and several more submitted from various sectors of the industry. A brief description of the projects and their objectives is presented below:

98/300: Propagation of rock lobster - development of a collaborative national project with international partners

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

1. Identify potential for the development of commercial culture of rock lobster in Australia and determine the research and development required to achieve this potential.
2. Identify what resources (expertise, facilities, funds) are required to conduct the necessary research and development.
3. Identify potential international and national research and industry partners who are interested in collaborative research into culture of rock lobster from eggs.
4. Develop a research plan mapping out research and development projects, the collaborative partners, timelines and resources.
5. Submit a proposal to FRDC under the rock lobster enhancement and aquaculture subprogram.



98/301: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.

Principal Investigator: Dr Robert van Barneveld
(Barneveld Nutrition Pty Ltd, PO Box 42, Lyndoch, SA, 5351)

Project Objectives:

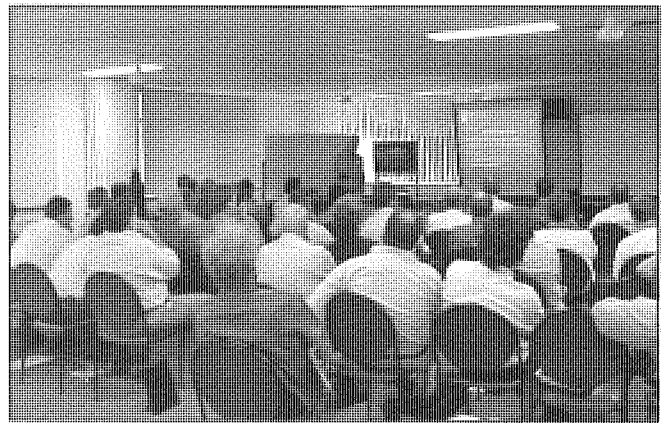
1. Coordinate the FRDC Rock Lobster Enhancement and Aquaculture Subprogram (applications, workshops, communication).
2. Conduct an annual research workshop to present research outcomes from the subprogram and to define research objectives for subsequent years.
3. Facilitate travel of the subprogram project Principal Investigators, a nominated industry representative and the Subprogram Leader to biannual scientific meetings.
4. Facilitate travel of industry representatives and the Subprogram Leader to biannual Steering and Management Committee meetings.
5. Coordinate the preparation of a subprogram newsletter, media releases and workshop publications.
6. Integrate with other FRDC and externally funded rock lobster research programs (eg The FRDC Rock Lobster Post-Harvest Subprogram).

98/302: Towards establishing techniques for large-scale harvesting of pueruli and obtaining a better understanding of mortality rates

Principal Investigator: Dr Bruce Phillips
(Fisheries WA, WA Marine Research Laboratories, PO Box 20, North Beach, WA, 6020)

Project Objectives (Revised June, 1999):

1. To determine appropriate puerulus to legal size survival rates and potential harvesting ratios, that if implemented in the western rock lobster fishery, might result in "biological neutrality" being achieved.
2. To establish techniques for large scale harvesting of pueruli for rock lobsters.
3. To collaborate with scientists conducting puerulus collection research in Tasmania.



More than 50 people attended the first annual Rock Lobster Enhancement and Aquaculture Subprogram workshop held in Geraldton, WA in March, 1999. Two more annual workshops will be coordinated through project 98/301 as part of this initial phase of the Subprogram.

98/303: Feed development for rock lobster aquaculture

Principal Investigator: Dr Kevin Williams
(CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

Project Objectives:

1. Review the state of knowledge of crustacean and fish nutrition of relevance to the development of formulated feeds for rock lobsters.
2. Develop a 'best guess' formulated diet for juvenile and adult rock lobsters (for tropical, *Panulirus ornatus*, western, *P. cygnus* and southern, *Jasus edwardsii* species) for comparative trialing against existing 'fresh' diet.
3. Determine the response of post-pueruli/juveniles and adult rock lobsters to key nutrients critical for the development of cost-effective formulated diets for rock lobsters.
4. Make recommendations on the direction of future nutrition research.

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages

Principal Investigator: Assoc Prof Louis Evans
(Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

Project Objectives:

1. To establish a national network of rock lobster health and disease personnel.
2. To conduct a symposium on health and disease management in lobster aquaculture and long-term holding facilities
3. To collate and document the current state of knowledge on rock lobster diseases.
4. To provide a disease diagnosis service for existing FRDC rock lobster projects in Queensland, South Australia and Western Australia.



98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out

Principal Investigator: Assoc Prof Mike Geddes

(University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

Project Objectives:

1. Assess the interactions between stocking density and feed delivery system on maintaining and improving condition and on the growth performance of adult rock lobsters in existing sea-based holding systems in different seasons.
2. Determine the effects of temperature, salinity and photoperiod on the growth rate and survival of juvenile rock lobsters in existing land-based holding systems.
3. Determine the effects of stocking density and shelter on the growth rate and survival of juvenile rock lobsters in existing land-based holding systems.
4. Evaluate existing system design and management regimes for land-based captive grow out of juvenile rock lobsters and for sea-based holding of adult rock lobsters.

99/314: Preliminary investigation towards ongrowing puerulus to enhance rock lobster stocks while providing animals for commercial culture

Principal Investigator: Mr Caleb Gardner

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Taroona, TAS, 7053)

Project Objectives:

1. To develop methods to capture large numbers of 1 year old benthic juvenile rock lobsters, both for providing control animals and for monitoring survival of reseeded animals (note that this is not puerulus collection).
2. To determine the extent of movement of reseeded and control juveniles after release, to assist in estimation of survival.
3. To develop methods to assess relative survival of cultured juvenile lobsters released into a natural habitat.

99/315: Propagation techniques

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Taroona, TAS, 7053)

Project Objectives:

1. Develop an artificial diet acceptable to phyllosoma of three species of rock lobster, that is water stable and easily manipulated through:
 - Characterising the morphology and function of the larval digestive system;

- Examining the biochemical changes in cultured and wild phyllosoma;
- Developing a best guess formulated diet for use in nutritional experiments;
- Examining the suitability of diets for phyllosoma of rock lobster.

2. Examine mass culture systems and determine environmental requirements for phyllosoma of three species of rock lobster by:
 - Examining mass culture systems using southern rock lobster phyllosoma;
 - Examining environmental requirements of southern rock lobster phyllosoma;
 - Examining environmental requirements of tropical rock lobster phyllosoma;
 - Examining the effects of temperature and food density on phyllosoma of the western rock lobster.
3. Develop hormonal control of moulting in rock lobsters by conducting a scoping study to examine the hormonal sequence controlling moulting in phyllosoma of a test species.
4. Determine the health status of phyllosoma of southern rock lobster under culture conditions.

The Subprogram Steering Committee...

This Subprogram is highly responsive to the views of industry and understands the need to accommodate both the research requirements of the future and the needs of the existing wild fisheries and aquaculture industries.

To ensure that research conducted within the Subprogram is relevant and meets the above criteria, a Steering Committee has been established to:

- Provide industry feedback and views;
- Review existing research based on FRDC contractual obligations;
- Prioritise new proposals and provide a priority list for other agencies;
- Ensure outcomes are commercially focussed;
- Coordinate industry and research provider involvement ensuring optimum use of resources;
- Facilitate extension and technology transfer.

Membership of the Steering Committee includes:

Robert van Barneveld (Chair)	Patrick Hone (FRDC)
Pheroze Jungalwalla (TAS)	Neil Stump (TAS)
Lionel Carrison (SA)	Greg Ward (SA)
Barry Spurrier (VIC)	David Lucas (VIC)
Jim Fogarty (QLD)	Ian Finlay (WA)
John Newby (WA)	Peter Auguston (WA)
Bruce Phillips	

(FRDC Rock Lobster Post-Harvest Subprogram Leader)



Optimum environmental and system requirements for on-growing rock lobster

The following results have been prepared by Dr Simon Bryars who is working on Subprogram project 98/305 (Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out) within the Department of Environmental Biology at the University of Adelaide. This report highlights the South Australian components of this research project.

Port Lincoln summer holding experiments

Aim: To evaluate the effectiveness of two different feeds and a 'natural' diet in maintaining condition and promoting growth at moult over the summer moult in male rock lobster.

Experimental design: Two experiments were conducted over the period November 1998 to March 1999:

1. Sea-based cage system (Boston Bay)
 - Four treatments: no feed, live mussels (natural feed), dry pellets (manufactured feed), and moist pellets (manufactured feed).
 - 40 male lobsters of approximately 500-600g weight per treatment (except no feed with 20 only).
2. Land-based raceway system (South Australian Mariculture site)
 - Two treatments: dry pellets (manufactured feed), and moist pellets (manufactured feed).
 - 40 male lobsters of approximately 500-600g weight per treatment.

Summary of results (see Table 1 for details):

- Feeding appears necessary for maximum survival and weight gains in long-term holding;
- Male lobsters can survive long-term holding over the warm summer period in Boston Bay;
- Male lobsters will moult and put on weight in sea-based and land-based holding facilities;
- Tail fan damage was evident in all treatments in both systems;
- Individual weight gains were highly variable within all treatments and were influenced to some extent by the moult stage of animals entering the experiments.

Kangaroo Island summer holding experiments

Aim: To evaluate the effectiveness of different feeds in promoting moult and improving condition and colour in poor condition, "white" male rock lobsters.

Experimental design: An experiment was conducted over the period December 1998 to March 1999 in a sea-based cage system at Kingscote on Kangaroo Island:

- Three treatments: octopus (natural feed), dry pellets (manufactured feed), and moist pellets (manufactured feed).
- 38 speckled/white male lobsters of approximately 400-600g weight per treatment.

Summary of results (see Table 2 for details):

- The colour of white/speckled male lobsters can be improved through live-holding and feeding;
- White/speckled male lobsters will moult and put on weight in sea-based holding facilities;
- Octopus can be used to feed lobsters in live-holding facilities;
- Tail fan damage was evident in all treatments;
- Individual weight gains were highly variable within each treatment and were influenced to some extent by the moult stage of animals entering the trial.

Current research

Two winter experiments are currently underway at Port Lincoln and Kangaroo Island with the following aims:

1. To evaluate the effectiveness of different feeds in maintaining condition and promoting growth at moult over the winter moult in male rock lobster.
2. To evaluate the effectiveness of different diets in promoting moult and improving condition and colour in "white" female rock lobsters.

Future research

It is suggested that future research should address the following points:

- **Moult stage** - There is evidence from the present study that upon entry to the holding systems, those lobsters in the pre-moult stage moulted sooner and had larger weight gains than lobsters in the intermoult stage. It is therefore envisaged that by selecting pre-moult lobsters only from the catch for live-holding, the time taken until weight gain commences (ie. a moult) can be minimised and resulting final weight gains can be maximised.
- **Tail fan damage** - Tail fan damage is unattractive and may affect the market value of live-held lobsters. Determining methods for reducing tail damage are therefore vital for the future of the live-holding industry.
- **Husbandry** - Feeding regimes, pellet form, and holding conditions were probably not optimal in the present experiments. Increasing the frequency of feeding, improving pellet stability in water, providing shelters for moulting lobsters, and moving sea-based holding facilities to cooler waters are seen as possible methods for improving weight gains and condition in live-held lobsters.

Table 1. Survival and growth data for the summer holding experiments in Port Lincoln, SA.

(Moult numbers are those lobsters that had moulted and were still alive at the completion of the experiment; Means were calculated only from those lobsters that had moulted and which were hard-shelled at the completion of the experiment; Ranges for the means are shown in parentheses; lobsters initially averaged ~105-106mm carapace length (CL) and ~570g in weight)

Holding system	Treatment	No. alive	No. mortalities	% mortality	No. moulted	% moulted	Mean CL increment (mm)	Mean % CL increment	Mean weight gain (g)	Mean % weight gain
SEA CAGES	No feed	15	5	25	6	30	0.9	0.9 (0, 2.6)	11	1.9 (-5.0, 7.6)
	Dry pellet	38	2	5	21	53	1.9	1.8 (-0.9, 4.8)	27	4.7 (-5.2, 16.4)
	Moist pellet	38	2	5	24	60	2.1	2.0 (-0.8, 6.4)	40	7.1 (-3.0, 23.4)
	Mussels	38	2	5	27	68	2.4	2.2 (-0.2, 7.5)	46	8.0 (-0.9, 17.1)
RACEWAYS	Dry pellet	33	7	18	9	23	1.6	1.5 (-0.3, 3.6)	26	4.5 (0, 7.7)
	Moist pellet	31	9	23	16	40	1.2	1.2 (-0.5, 4.1)	30	5.4 (-0.8, 11.9)

Table 2. Survival and growth data for the summer holding experiment on Kangaroo Island, SA

(Details as for Table 1; Lobsters initially averaged ~100mm carapace length (CL) and ~500g in weight).

Treatment	No. alive	No. mortalities	% mortality	No. moulted	% moulted	Mean CL increment (mm)	Mean % CL increment	Mean weight gain (g)	Mean % weight gain
Dry pellet	30	8	21	7	18	1.2	1.2 (0, 2.3)	12	2.7 (-3.9, 6.4)
Moist pellet	30	8	21	5	13	2.0	2.0 (0.9, 4.3)	10	2.0 (-2.5, 8.2)
Octopus	28	10	26	7	18	2.3	2.3 (0.3, 4.7)	33	7.1 (-0.9, 13.8)

Meetings and Workshops...

In addition to the first annual Subprogram workshop, two additional workshops have been organised as part of the Rock Lobster Enhancement and Aquaculture Subprogram. The following outlines the objectives and outcomes of these workshops.

Rock lobster health workshop

Assoc Prof Louis Evans convened a rock lobster health workshop in Bentley, WA in June, 1998. The main aim of the workshop was to provide a forum for researchers and industry personnel to discuss current and likely future problems arising from disease outbreaks in post harvest and cultured lobsters and to identify future research priorities.

Presentations at the workshop included a review of rock lobster health and disease processes, physiological stress responses in post harvest lobsters and lobster disease case studies.

A proceedings from the workshop will be available from September for a fee to be determined. Contact Robert van Barneveld on 08 85 246 477 for further details.

Propagation workshop

As a main objective of FRDC project 98/300 "Propagation of rock lobster - Development of a collaborative national project with international partners", a workshop was convened in Tasmania from January 29-31, 1999 by Dr Piers Hart. This workshop focussed on the practical and economic feasibility of propagating various species of rock lobsters from eggs to juveniles for use in aquaculture systems or for enhancement of the wild fishery.

The workshop was held over a period of three days and involved scientists and members of industry from Australia, New Zealand and Japan. The first day was devoted to formal presentations from individuals working in relevant research areas. The second day was used to workshop the economic and practical feasibility of propagating rock lobsters commercially and to inspect the research facilities at the Tasmanian Aquaculture and Fisheries Institute (TAFI). The final day focussed on the documentation of research and development priorities, identified research providers and established a timeline and framework for the preparation of a research submission to FRDC.

While many questions remain unanswered, sufficient information is currently available to suggest that rock lobster propagation is not only practically feasible, but there are strong indications that a rock lobster hatchery could be economically viable. On this basis, it was agreed that a research and development plan should be pursued and a funding application submitted to the FRDC. It should also be noted that there was significant industry support for

the proposal with potential investors prepared to consider contributions to the research program.

To define research and development priorities for rock lobster propagation the workshop examined the state of knowledge surrounding the fundamental processes required to operate a commercial hatchery. It was agreed that sufficient information and expertise exists to establish a pre-breeding (wild broodstock, egg quality, larval viability), breeding and hatch-out program in the short term. Significant deficiencies exist in our knowledge of larval rearing with the major issues surrounding larval survival, growth and nutrition and the length of the larval phase.

To improve our understanding of larval rearing, a collaborative research program was developed as part of FRDC Rock Lobster Enhancement and Aquaculture Subprogram involving the Tasmanian Aquaculture and Fisheries Institute together with a range of institutions across Australia and New Zealand. The project focussed on interactions between nutrition and feeding, environment and health in the larval phases.

The submission was subsequently funded by the FRDC (Project 99/315) and research work has commenced. Preliminary outcomes from this project should be available at the next RLEAS annual workshop.

Proceedings from this workshop will be available from September for a fee to be determined. For further information contact Robert van Barneveld on 08 85 246 477.

Coming Events...

- An international symposium on lobster health management will be held in Adelaide between September 19-21, 1999 and will include information generated within the health component of the Rock Lobster Enhancement and Aquaculture Subprogram. The symposium is designed to encourage the exchange of ideas, information and knowledge between scientists and industry personnel on health management of lobsters and other commercially important crustaceans.
- The Rock Lobster Enhancement and Aquaculture Subprogram will have a presence at the forthcoming 3rd International Lobster Congress being held in Adelaide from September 21-24, 1999. A large number of the project Principal Investigators will be present and will participate in a number of industry meetings planned in conjunction with the Congress.
- The third Subprogram Scientific Committee meeting will be held in Adelaide on Friday, September 24, 1999.
- The third Subprogram Steering Committee meeting will be held in Adelaide on Monday, September 27, 1999.



- The second annual workshop of the Rock Lobster Enhancement and Aquaculture Subprogram will be held in March 2000. The Subprogram intends to move the annual workshop to a different location each year with the 2000 workshop currently planned for Tasmania. Further details will be provided in the next issue of "Lob ReLEASE".

Research Priorities...

The Subprogram Leader is in the process of preparing a 5 year strategic research and development plan for rock lobster enhancement and aquaculture research in Australia due for release by November, 1999.

A number of priorities have been developed in the past and are actively being addressed by existing projects within the Subprogram.

Two additional priorities have been clearly indicated by those involved in rock lobster enhancement and by the wild fishing sector, respectively. The first involves the incidence of tail fan damage in rock lobsters kept in tanks or cages for an extended period of time (see Research News in this newsletter). The second is the need to improve our understanding of the potential economic impact of the introduction of rock lobster aquaculture products into the market and how aquaculture and wild caught products can coexist in the market place.

Current research programs in Australia, New Zealand and Japan will be assessed as part of the development of this strategic plan. Any industry body or research group interested in making submissions to this plan should contact Robert van Barneveld at their earliest convenience.

Mailing List...

Do you want to be on the Rock Lobster Enhancement and Aquaculture Subprogram mailing list?

If so, please provide your details by phone (08 85 246 477) or fax (08 85 246 577) to Robert van Barneveld who will ensure you receive all information on upcoming events and outcomes from the Subprogram.

Newsletter Submissions...

We are keen to extend information on any rock lobster enhancement and/or aquaculture activities in Australia and overseas. If you wish to make a submission to the next issue of this newsletter (research results, letters to the editor, industry rock lobster enhancement and aquaculture developments) please contact Robert van Barneveld by January 31, 2000.

CSIRO Visiting Fellow to Work with Rock Lobster Enhancement and Aquaculture Subprogram...

Professor Charles (Rick) Phleger from the Department of Biology at San Diego State University has been recently awarded a CSIRO McMaster Fellowship. He will join CSIRO Marine Science for 6 months in early 2000 to work within the Rock Lobster Enhancement and Aquaculture Subprogram. His project will be closely associated with this new FRDC initiative and at this stage the intention is for Professor Phleger to define the process of energy accumulation and depletion during key late stage development of the cultured Australian rock lobster phyllosoma. In addition he will compare results from experimental animals with that occurring naturally in wild-caught animals. Results from these experiments will be of use for defining the most suitable feeds for rock lobster larviculture, including the development of artificial diets.

Culture experiments performed during the project will be carried out at the TAFI Marine Research Laboratories in Tarooma (with Drs Hart and Ritar). Experiments will be performed to determine changes in Biochemical composition of late stage (VIII to XI) phyllosoma when the animals are either fed or starved during the intermolt period. Late stage phyllosoma have been selected as these are seen as difficult yet key stages during animal development. The proposed research will complement studies of early stage animals to be performed by TAFI, CSIRO and other researchers over the coming 12 months as part of the new FRDC initiative.

Professor Phleger has extensive aquaculture research experience across a range of species (eg. salmon, scallops and abalone). He will bring to the new Australian aquaculture research initiative in rock lobster considerable experience in marine food-chains and signature lipids that will be highly beneficial to the farming of the Australian rock lobster species. Considerable research has been performed on the nutrition of the American lobster *Homarus americanus*. Professor Phleger will bring knowledge gained from this species by Californian researchers to the Australian projects.

Rock Lobster Aquaculture Status...

There is a growing interest in the culture of rock lobster in Australia and overseas. Although there is presently no commercial ongrowing of puerulus or closed life cycle production, there is considerable interest from commercial groups, there is already some ongrowing of adults and the FRDC has funded a series of research projects to investigate aspects of rock lobster culture. In the short term there is likely to be a limited number of licenses issued for pilot scale puerulus ongrowing trials in some states, and the life cycle may be closed in the future with a consequent up scaling and expansion of output.



Diet Induced Colour Changes in Southern Rock Lobster...

The dramatic change in the colour of southern rock lobsters, *Jasus edwardsii*, in response to various diets is illustrated in the picture below. A simple colour chart has been used to rank these lobsters and a strong correlation was found between the colour rank and the carotenoid level in the diet. For *J. edwardsii* a dietary level of about 100 mg/kg produces lobsters which are close to the 'natural' colour of wild-caught juveniles. Further research is required to examine the carotenoid level in manufactured diets for two reasons including i) the final colour may dramatically affect the market price of lobsters, and ii) carotenoids are expensive, therefore minimal levels for inclusion in diets need to be determined.



FISHERIES
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SUBPROGRAMS



Lob ReLEASE is the principal industry communication of the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) coordinated by the Fisheries Research and Development Corporation.

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Lob ReLEASE

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DEVELOPMENTS IN ROCK LOBSTER ENHANCEMENT AND AQUACULTURE RESEARCH

From the Subprogram Leader...

Welcome to the second issue of "Lob ReLEASE", the principal industry communication of the Fisheries Research and Development Corporation Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS). We are now 2.5 years into our initial Subprogram and have made significant progress towards developing technologies for use in commercial rock lobster aquaculture and enhancement. Commercial rock lobster aquaculture will soon be a reality in Australia with in-principle agreements reached between the wild capture fishery and the Rock Lobster Grower's Association in Tasmania for the collection and on-growing of puerulus with provision for return of a proportion of the on-grown juveniles to the wild.

The RLEAS has now convened two national workshops, has hosted a lobster health workshop in Western Australia, a lobster propagation workshop in Tasmania, and an international symposium on lobster health management in South Australia in conjunction with the Third International Lobster Congress. In addition, a number of the initial subprogram projects have now been completed including those investigating lobster nutrition, lobster health, system design and husbandry, enhancement of wild stocks with aquaculture reared juveniles and preliminary investigations into lobster propagation. Workshop and conference proceedings and information on final reports can be obtained by contacting me by phone (08) 8524 6477, mobile 0418 802 462 or e-mail robvanb@dove.net.au. The subprogram has also continued to expand with a number of new projects approved by the FRDC Board in the last funding round. A large collaborative project between the Tasmanian Aquaculture and Fisheries Institute (TAFI), CSIRO Marine Science, and the National Institute of Water and Atmospheric (NIWA) Research in New Zealand will investigate ways to improve our capacity to propagate rock lobsters from eggs to puerulus in a commercially viable time frame. Another project involving CSIRO

Marine Science, NIWA, TAFI and the University of Adelaide will examine the nutrition of juveniles in their first year of development. Dr Mike Hall from AIMS in Townsville will investigate the hormonal manipulation of rock lobster larval phases in an attempt to shorten the length of the larval phases while Dr Caleb Gardner from TAFI will continue to investigate the survival of aquaculture reared juveniles when released back to the wild. Tail fan damage will be investigated by the University of Adelaide and the South Australian Research and Development Institute.

In this issue of Lob ReLEASE we will outline the objectives of new projects within the Subprogram, list projects that have been completed within the Subprogram, provide an insight into rock lobster aquaculture and enhancement research in New Zealand, examine some of the basic husbandry research that has been underway in Tasmania, compare the advantages and disadvantages of re-seeding over quota buy-out schemes, examine the economics of puerulus collection and provide information on upcoming events, publications, and industry developments.

Dr Robert van Barneveld
RLEAS Leader

RLEAS Workshop 2001...

The 2001 RLEAS workshop will be an event not to be missed. It will provide an opportunity to summarise all research completed within the first phase of the Subprogram as well as future research developments.

The workshop will be held in Wellington in New Zealand from March 20-23, 2001. It will consist of invited presentations by researchers and members of the rock lobster industry from Australia and New Zealand, visits to commercial rock lobster facilities and government rock lobster aquaculture research establishments and strategic planning meetings over the course of 4 days. Further details will be posted as they become available.



New Subprogram Projects...

The FRDC Board approved five new projects within the RLEAS commencing on July 1, 2000. The projects were based on priorities and directions defined by the RLEAS Steering Committee using outcomes from research completed to date and identified limitations to the future development of rock lobster enhancement and aquaculture systems. The projects are consistent with the Subprogram mission "to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries".

2000/185: Evaluating the release and survival of juvenile rock lobsters released for enhancement purposes

Principal Investigator: Dr Caleb Gardner

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

- To develop release protocols to minimise mortality based on the anti-predator behaviour of wild and cultured juvenile *J. edwardsii*.
- To provide recommendations on release (micro) habitats for optimising the benefit of enhancement operations.
- To evaluate the conclusions of objectives 1 and 2 in pilot scale enhancement experiments.

2000/211: Investigation into tail rot necrosis in live-held adult rock lobsters

Principal Investigator: Assoc Prof Mike Geddes

(Department of Environmental Biology, University of Adelaide, Adelaide, SA, 5005)

Project Objectives:

- Identify potential causes of tail fan necrosis in live-held adult southern rock lobster.
- Provide advice on possible preventative methods for reducing the incidence of tail fan necrosis in live-held adult southern rock lobster.

2000/212: The nutrition of juvenile and adult lobsters to optimise survival, growth and condition.

Principal Investigator: Dr Kevin Williams

(CSIRO Division of Marine Research, Cleveland Marine Laboratories, PO Box 120, Cleveland, Qld, 4163)

Project Objectives:

- Develop manufactured feeds for juvenile rock lobsters (ie puerulus – year 1 and beyond) that optimise survival and growth by a) defining the chemico-physical cues that stimulate food consumption in juvenile rock lobsters, b) developing pelleted feeds that remain attractive to lobsters for periods in excess of four hours after immersion, and c) determining the optimum dietary specifications of selected nutrients required by juvenile rock lobsters for growth and development.
- Develop manufactured feeds for adult lobsters for body maintenance and moult manipulation by a) determining the optimum pellet size and feeding frequency for maintaining the condition of adult rock lobsters and b) providing continued advice to project 98/305 on lobster feeds development for adult lobster holding.

2000/214: Advancing the hatchery propagation of rock lobsters

Principal Investigator: Dr Bradley Crear

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

- To demonstrate that nutrient supply is a limiting factor in the growth and survival of rock lobster phyllosoma by the identification of a) which nutrients are critical, b) which nutrients are rock lobster phyllosoma adapted to digest, and c) whether we can manipulate growth through manipulation of nutrient supply.
- To reduce the reliance on live feed for rearing of rock lobster phyllosoma by the identification of a) what stimuli are required to make formulated diets more attractive to phyllosoma, and b) what factors influence the consumption of formulated diets.

2000/263: Reducing rock lobster larval rearing time through hormonal manipulation

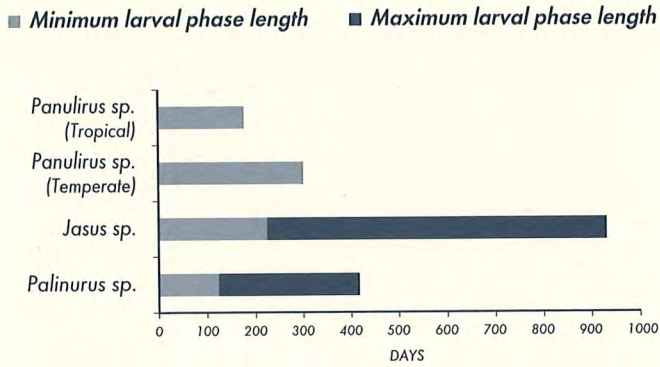
Principal Investigator: Dr Mike Hall

(Australian Institute of Marine Science, Marine Biotechnology, PMB No 3, Townsville Mail Centre, Qld, 4810)

Project Objectives:

- To identify hormonal triggers for moulting to evaluate a shortening of the larval phase.





Outcomes: The outcome of the workshop was that, while many questions remain unanswered, sufficient information is currently available to suggest that rock lobster propagation is not only practically feasible, but there are strong indications that a rock lobster hatchery could be commercially viable. On this basis, it was agreed that a research and development plan should be pursued and a funding application submitted to FRDC for an initial 1 year research project with an expectation of a longer and more elaborate project to follow. These recommendations were obviously endorsed with these two projects subsequently being funded by FRDC.

98/303: Feed development for rock lobster aquaculture

Principal Investigator: Dr Kevin Williams

(CSIRO Division of Marine Research, Cleveland Marine Laboratories, PO Box 120, Cleveland, Qld, 4163)

Final Report Status: Pending

Outcomes: This project has addressed a range of issues associated with the nutrition of juvenile and adult lobsters including the successful development of manufactured feeds for captive lobsters.

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages

Principal Investigator: Assoc Prof Louis Evans

(Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

Final Report Status: Pending

Outcomes: A lobster health network was successfully established as part of this project and an international symposium on lobster health management was convened in conjunction with the Third International Lobster Congress in South Australia.

98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out

Principal Investigator: Assoc Prof Mike Geddes

(Department of Environmental Biology, University of Adelaide, Adelaide, SA, 5005)

Final Report Status: Draft final report submitted for consideration by the RLEAS Steering Committee and FRDC.

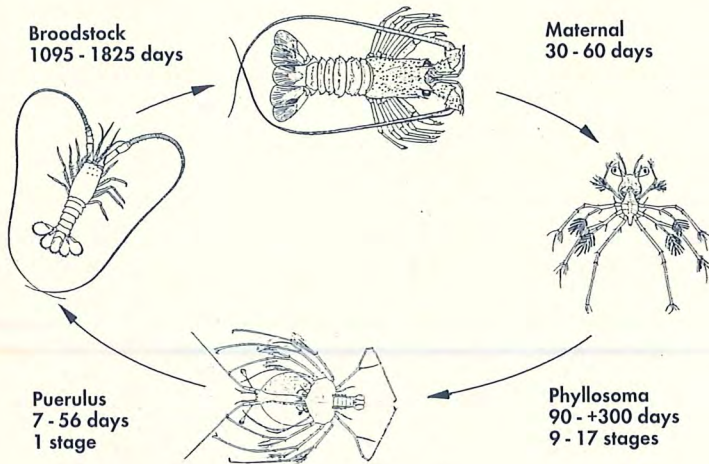


Figure 1. Closure of the spiny rock lobster life cycle and reduction in larval phase length are both critical to the success of commercial rock lobster aquaculture. These research areas are the highest priority for the RLEAS (figure courtesy of Dr Mike Hall, Australian Institute of Marine Science).

Completed Subprogram Projects...

A number of Subprogram projects have now been completed. A short summary of the outcomes from some of these projects and the status of final reports is presented below. Copies of final reports that have been accepted by FRDC can be obtained from the Subprogram Leader.

98/300: Propagation of rock lobster – development of a collaborative national project with international partners

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: A final report in the form of workshop proceedings has been accepted by FRDC.



Outcomes: Outcomes from this project will allow aquaculturalists, rock lobster fishers and processors to make better informed decisions about holding systems, holding times, feeding regimes, feed types and selection of lobsters and long term live-holding of *Jasus edwardsii*. In addition, the project has defined temperature, salinity and density optima for the tank culture of *P. ornatus*, basic production protocols for *P. ornatus*, and the commercial aquaculture potential of *P. ornatus*.

99/314: Preliminary investigation towards ongrowing puerulus to enhance rock lobster stocks while providing animals for commercial culture

Principal Investigator: Dr Caleb Gardner

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: Draft final report submitted for consideration by the RLEAS Steering Committee and FRDC.

Outcomes: Survival results from this project are encouraging for the future of reseeding aquaculture grown juveniles, however, caution is urged in their interpretation. There is evidence that survival varies greatly between habitats and/or regions, and seasonal effects are also likely. Most importantly, this study has shown that obtaining accurate estimates of short term survival of juvenile lobsters is both possible and practical. There is confidence that results from the model, and new knowledge on juvenile lobster movement can be used to design a robust study to predict likely survival of reseeded lobsters across habitats, geographic regions and seasons.

99/315: The development of rock lobster propagation techniques for aquaculture in Australia

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: Pending

Outcomes: The results from this project have begun the construction of a picture of phyllosoma development over time, which can be related to the structure of a potential culture technology (see figures 2a and 2b). This information has been used to develop a further submission to FRDC for continued research into the propagation of lobsters with a focus on nutrition.

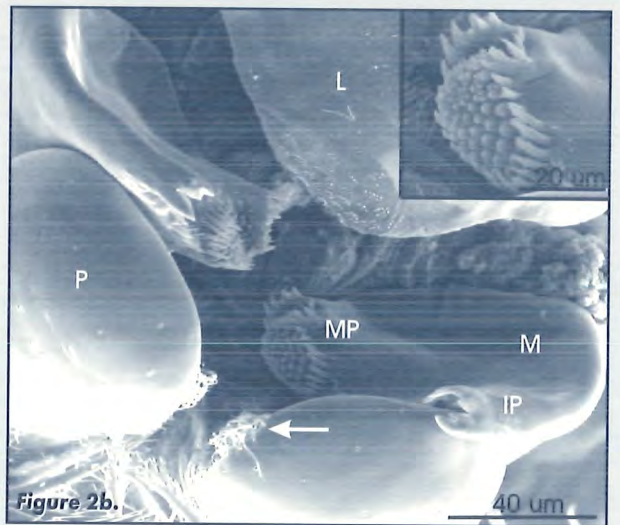
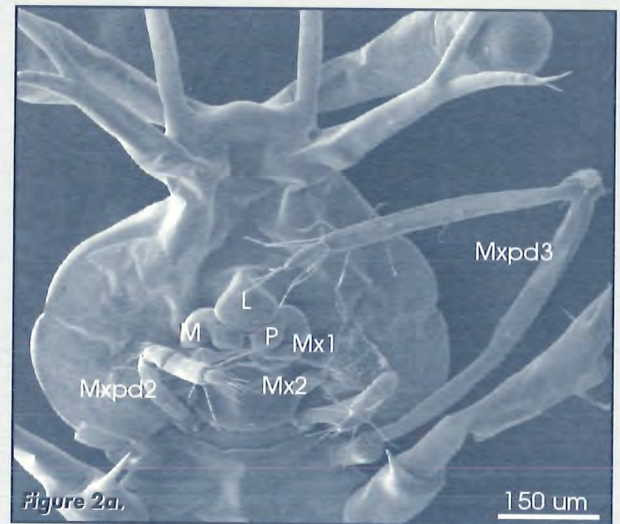


Figure 2a. Mouthparts of stage II *Jasus edwardsii* phyllosoma.
Figure 2b. Ventral view of the mandibles, paragnaths and labrum. Inset, Fine structure of the mandibular molar process.
IP, incisor process; L, labrum; M, mandible; MP, molar process; Mx1, maxilla 1; Mx2, maxilla 2; Mxpd 2, maxilliped 2; Mxpd 3, maxilliped 3; P, paragnath. Arrow indicates setae on paragnaths.

As part of project 99/315 Dr Danielle Johnston, Dr Arthur Ritar and Dr Piers Hart from the Tasmanian Aquaculture and Fisheries Institute investigated mouth part structure to provide clues as to the optimum form of phyllosoma diets

The structure of the mouthparts of *Jasus edwardsii* phyllosoma, shown in figures 2a and 2b, suggest that phyllosoma are well adapted for ingesting fleshy items and gelatinous soft bodied zooplankton. They have well developed incisor and molar processes (IP,MP) on their mandibles (M) with strong sharp spines on their inner and outer mouthparts (Mx1, Mxpd2, Mxpd3) to pierce, thresh and cut flesh. Mouthpart morphology changes little during larval development, indicating that ingestive capabilities and external mastication are well developed from an early age. However, the density and complexity of setation and robustness of individual mouthparts increases with age, suggesting a greater capacity to ingest larger prey during development. These results, in addition to complementary work on gut structure, suggest that early stage phyllosoma would benefit from a diet comprising soft gelatinous items, such as medusae, ctenophores and chaetognaths while late stage phyllosoma are better prepared to deal with larger, fleshy prey such as mussel flesh and fish larvae. The results of this study also suggest that microencapsulated diets or soft gelatin coated capsules or pastes may be suitable for culture, particularly for early stage phyllosoma. Future research is proposed on the digestive enzymology complement of *J. edwardsii* phyllosoma to determine their digestive capabilities to further optimise larval diets.

Lobster Congress

A large contingent of RLEAS contributors recently attended an international lobster congress in Florida, USA. Researchers who attended the conference included Assoc Prof Bruce Phillips, Dr Roy Melville-Smith, Dr Danielle Johnston, Dr Clive Jones, Dr Caleb Gardner and Dr Bradley Crear.

Dr Piers Hart and Dr Simon Bryers move on

Two major contributors to the first phase of the RLEAS have left their current employment to pursue other interests. Piers Hart is working for a private aquaculture enterprise, but will maintain inputs into the RLEAS as an independent scientific adviser to the Steering Committee. Simon Bryers has secured employment as a Marine Biologist within the University of Adelaide. Thanks to both Piers and Simon for their significant inputs into the RLEAS.

Queensland Rock Lobster Association Inc.

The catching and post harvest sections of the tropical rock lobster industry of Queensland have decided to incorporate an association known as the "Queensland Rock Lobster Association Inc." which will represent the views of the catching and post harvest section of both the East Coast Fishery and the Torres Straits Fishery.

The Association's main objectives will be to provide input to the management plans of both fisheries but it will also be very interested in following any research proposals which will be promulgated by the FRDC Subprograms.

QDPI/MG Kailis alliance

A major research alliance has been established between MG Kailis and the Queensland Department of Primary Industries to investigate the propagation and grow-out of tropical rock lobsters. Research within this alliance will be closely related to the RLEAS and where possible research results will be actively communicated between the programs.

Puerulus collection in Tasmania

Negotiations continue between the wild fishing sector and those interested in on-growing wild caught puerulus in aquaculture systems in Tasmania. Negotiations centre on how the collection and reseeded process will be monitored, including the size and health status of reseeded juveniles and how licences will be distributed and costed.

The following summary has been prepared by Dr Bradley Crear from the Tasmanian Aquaculture and Fisheries Institute. Detailed results have recently been published in *Aquaculture* **190**: 169-182 "Growth of juvenile southern rock lobsters, *Jasus edwardsii*, is influenced by diet and temperature, whilst survival is influenced by diet and tank environment" by B.J. Crear, C.W. Thomas, P.R. Hart and C.G. Carter.

The effect of temperature on growth and survival of small juvenile southern rock lobsters, *Jasus edwardsii*

In Tasmania, there is likely to be a limited number of licenses issued for pilot scale on-growing trials of wild-caught southern rock lobster (*Jasus edwardsii*) puerulus. This will allow lobster growers the opportunity to develop grow-out techniques whilst research into hatchery production of puerulus continues. Access to hatchery-reared puerulus will allow for up scaling and expansion of output in the future.

The Tasmanian component of the RLEAS Project 98/305 (Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out) is concentrating on juvenile *J. edwardsii* grow-out. The research is being undertaken at the Tasmanian Aquaculture and Fisheries Institute's, Marine Research Laboratory in Tarooma, Hobart.

Temperature is one of the major environmental factors affecting the growth of crustaceans. Elevated temperature could potentially reduce the culture period, which would be important for the economic viability of *J. edwardsii* culture. Growth has been shown to increase with temperature to a maximum, before declining at the upper thermal limits.

Aim:

To determine the effect of temperature on survival, growth, feeding, oxygen consumption and ammonia excretion of small juvenile *J. edwardsii* and to identify the upper thermal limit and the most efficient temperature range for culture.

Experimental design:

- Temperatures of 18, 20, 22 and 24°C were tested (heated flow-through water).
- Initial mean weight of lobsters = 0.99 g.
- Three replicates tanks per treatment (13 lobsters per replicate).
- Lobsters were fed blue mussels and a formulated prawn growout feed.

- Oxygen consumption and ammonia excretion of lobsters was measured using closed system respirometry.
- The experiment ran for 4 months.

Summary of results:

The results of the experiment, outlined in Figures 3 and 4, showed that:

- the optimal temperature range for growth and feed efficiency was 19-21°C,
- growth and survival reduced at 24°C,
- oxygen consumption increased with temperature up to 22°C but decreased at 24°C,
- ammonia excretion increased with temperature,
- the intermoult period decreased with temperature up to 22°C but increased at 24°C,
- the moult increment decreased with temperature.

The study showed that a temperature range of between 19 and 21°C was optimal for small (1-10g) juvenile *Jasus edwardsii* in terms of survival, growth and feed efficiency. The reduced growth, survival and declining oxygen consumption at 24°C were indications that *J. edwardsii* had approached its upper thermal limit.

Culturists would need to consider the economic advantages of lobsters reaching market size in the shortest possible time against the increased costs associated with heating water. In addition, at higher temperatures lobsters had a greater respiratory requirement and excreted higher levels of ammonia. If lobsters are to be cultured at elevated temperatures in intensive recirculating aquaculture systems then there would be even greater reliance on water treatment, to ensure water quality is not limiting growth. Finally, these results indicate that if lobsters were to be grown in flow-through systems, or in cages in the sea, it would be necessary to select sites where summer water temperatures do not rise above 22°C.

Future Research:

It is likely that there will be size-specific optimal temperature ranges therefore the effects of temperature on growth of larger juveniles need to be investigated.

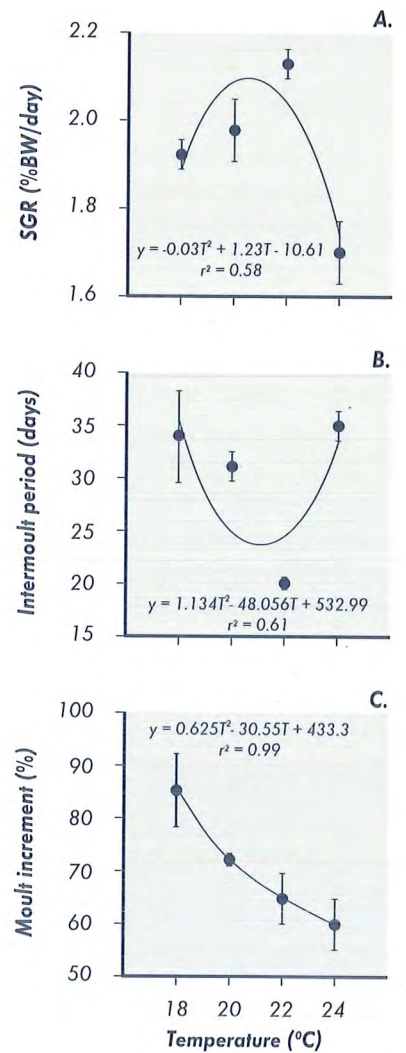


Figure 3. Growth response of *J. edwardsii* subject to elevated temperatures (mean±SE).
A. Specific growth rate (SGR) (%BW/day)
B. Intermoult period (days) **C.** Moult increment (%).

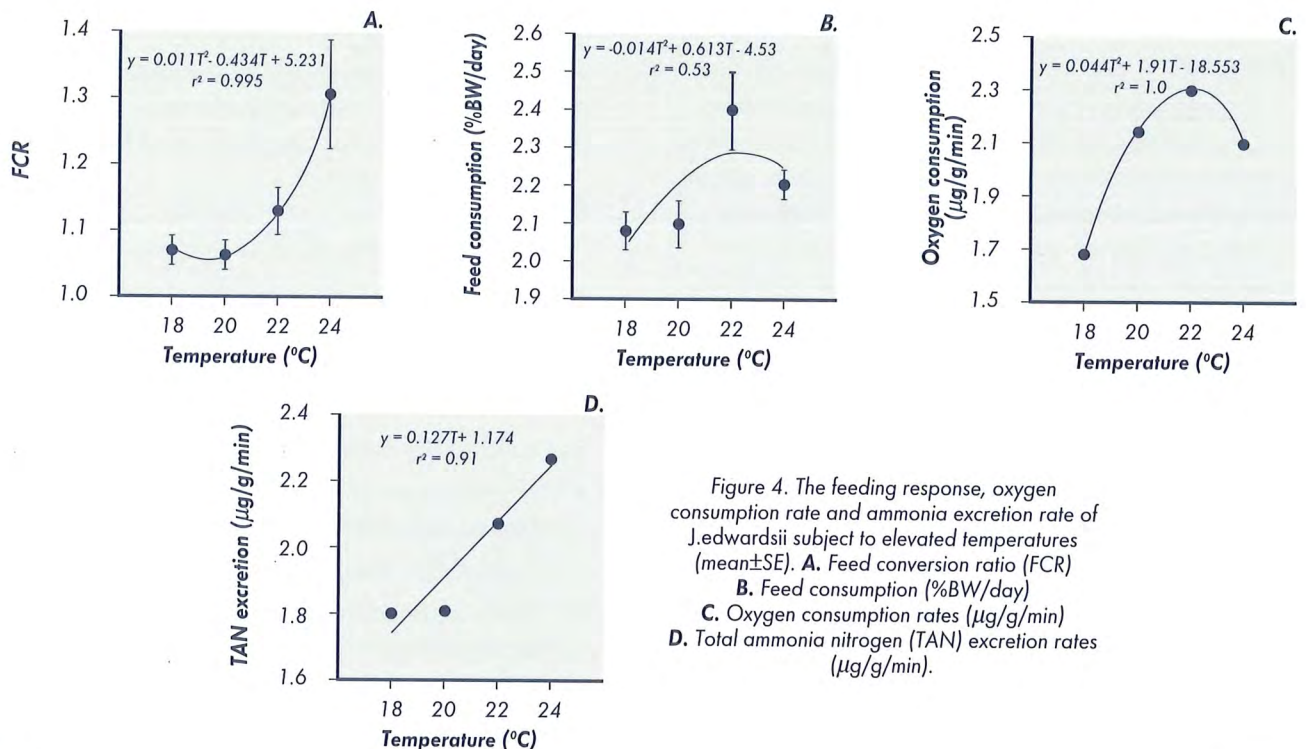


Figure 4. The feeding response, oxygen consumption rate and ammonia excretion rate of *J. edwardsii* subject to elevated temperatures (mean±SE).
A. Feed conversion ratio (FCR)
B. Feed consumption (%BW/day)
C. Oxygen consumption rates (µg/g/min)
D. Total ammonia nitrogen (TAN) excretion rates (µg/g/min).

Re-seeding vs Quota Buy Out...

The New Zealand commercial rock lobster aquaculture industry is currently based on a quota buy-out scheme. In contrast, the emerging Tasmanian rock lobster aquaculture industry will be based on a re-seeding scheme if current negotiations proceed as planned. Dr Stewart Frusher from the Tasmanian Aquaculture and Fisheries Institute recently compared the two schemes in a presentation at AQUAFEST 2000 suggesting the following benefits of re-seeding over quota buy out.

Quota buy-out

1. Requires estimation of mortality rates from puerulus to recruitment to the fishery.
2. Aquaculture at the expense of the size of the commercial fishery (ie. 500 tonnes aquaculture; commercial fishery = quota less 500 tonnes).
3. Cost of puerulus related to amount of quota purchased. Pre-fixed irrespective of how many puerulus can be caught in good or bad settlement years.
4. Limited scope for long term regional impact (fleet dynamics unpredictable). Quota purchased can not be guaranteed to remain in the region where the puerulus are sourced. Resource implications for recreational and other users of the resource (eg. tourism).
5. Does not address egg production 'loss' where females reproduce below the legal size limit.
6. Enhancement indirect (not regional) through excess buy out.

Reseeding

1. Requires estimation of mortality rates for the first year only. Relative survival rates required for second year to demonstrate that survival of the re-seeded population is similar to the wild population.

2. Aquaculture and commercial fishing industries potential growth is independent of each other.
3. Cost of puerulus is directly related to the amount of puerulus harvested.
4. Re-seeded juveniles can be returned to regions from where the puerulus were removed. No net regional loss.
5. Re-seeded puerulus should reproduce similar to the wild population (needs to be tested). Therefore no net loss of egg production.
6. Enhancements direct through excess re-seeding in specific locations.

Economics of Puerulus Collection...

Collector numbers and costs for these collectors have been estimated based on research completed by David Mills from the Tasmanian Aquaculture and Fisheries Institute. In a presentation at AQUAFEST 2000, David highlighted the average number of puerulus caught in a variety of collectors at a variety of sites. Using data from Bicheno (Figure 5) he found that collectors of his own design based on bunched shade-cloth averaged 7 puerulus per collector per month, or approximately 60 puerulus per collector per nine months.

Based on an average cost of \$AUD20.00 per collector, and assuming a puerulus collection license for 50,000 puerulus per annum, a total of 830 collectors would be required at a total cost of \$AUD16,600.00. This cost obviously does not include the cost of labour and collection.

While the above economic analysis is relatively simplistic, it serves to highlight the scope of resources required in a puerulus on-growing aquaculture system. More importantly, this research served to demonstrate the extreme variability that occurs with puerulus collection. Estimated annual collection rates over a 9 year period were between 22,800 and 112,700 puerulus using this number of collectors.

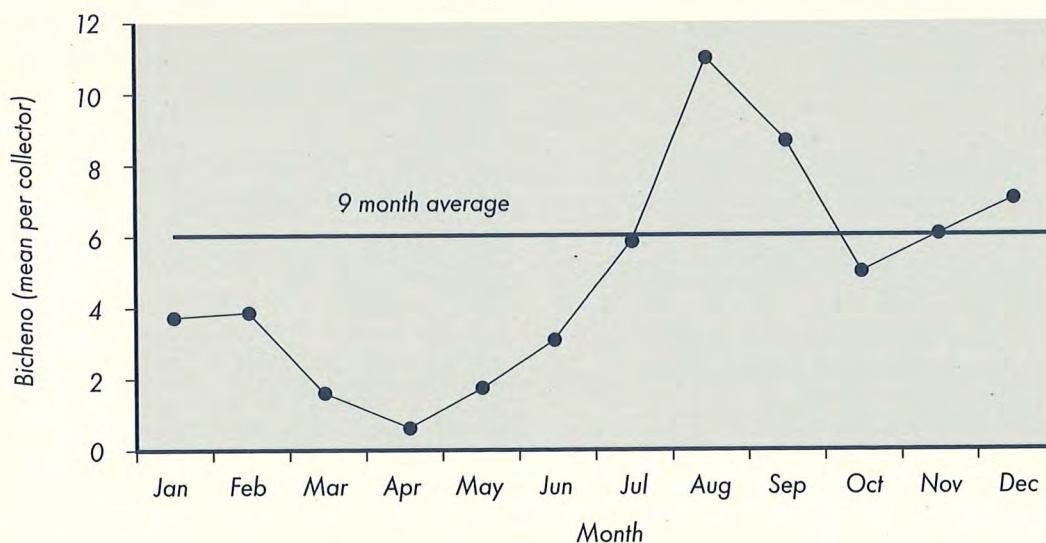


Figure 5. Long term average monthly settlement of puerulus in Bicheno (figure courtesy of David Mills, Tasmanian Aquaculture and Fisheries Institute).

Rock Lobster Enhancement and Aquaculture Research in New Zealand...

There are many parallels in the development of the rock lobster resource in Australia and New Zealand. Both countries have rock lobster species in common and are actively investing a great deal of research effort into increasing the lobster resource through new methods of enhancement and aquaculture. Dr Andrew Jeffs, a scientist with NIWA in New Zealand has prepared the following summary for Lob ReLEASE.

In New Zealand most of this research is being conducted by NIWA – the National Institute of Water and Atmospheric Research, which is the equivalent of CSIRO. NIWA currently spends in the vicinity of \$AUD600,000.00 on lobster aquaculture and enhancement research.

Aquaculture

The current focus of New Zealand aquaculture research is in developing the ability to raise juvenile lobsters from eggs in captivity. We have now succeeded in doing so in small numbers for two species of lobsters, but we still need to work out the methods for raising large numbers more cost effectively. The upwelling larval cultivation system developed in New Zealand has now been adopted by many researchers working in this area in Australia. We hope that closer collaboration with these Australian researchers through the RLEAS in the future will speed up progress in this area.

New Zealand currently has a small lobster on-growing industry based on the collection of juvenile lobsters from the wild fishery. Much of our recent research has been in finding effective methods for catching big numbers of these small lobsters and finding more cost effective methods for on-growing them. This has included the development of manufactured diets and a range of new culturing methods, including sea cages and land-based techniques.

Enhancement

There are excellent opportunities for the enhancement of the wild lobster fisheries in New Zealand. Unfortunately, we know little about the effectiveness of different enhancement techniques. Therefore, our enhancement research is focussed in three key areas; enhancing reproductive output, enhancing early juvenile survival, and release of on-grown juvenile lobsters to the wild.

Our research into egg production has strongly suggested that the age structure of lobster stocks can dramatically affect the reproductive output of the stock. These results could lead to new approaches to lobster fisheries management that would maximise reproductive output. There are good indications that in

the wild vast numbers of early juvenile lobsters are eaten by predators in some areas and this greatly affects the production of the overall fishery. We have been attempting to get a better understanding of the processes that affect this stage in the lifecycle. We aim to apply this knowledge to improve the survival of juvenile lobsters in the wild, through techniques such as providing protective artificial habitat in areas where juveniles do not normally survive. Enhancement of lobster fisheries through releasing juveniles back to wild is a technique which has been tried in some clawed lobster fisheries around the world, in some cases with quite promising results. We are investigating the potential for releasing juvenile lobsters in a manner that ensures their best chance of survival into the wild fishery.

It is clear that New Zealand has a lot of common interests with Australia in the area of lobster enhancement and aquaculture. Developing strong research linkages between the two countries will have significant mutual benefits in these areas of research which are complex and relatively costly. NIWA has already begun providing expertise and logistic support to a number of Australian lobster research initiatives, and these initial overtures are now being reciprocated.



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SUBPROGRAMS



Lob ReLEASE is the principal industry communication of the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) coordinated by the Fisheries Research and Development Corporation.

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DEVELOPMENTS IN ROCK LOBSTER ENHANCEMENT AND AQUACULTURE RESEARCH

From the Subprogram Leader...

This issue of "Lob ReLEASE" marks the end of the first phase of the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS). During our first 3 years a total of 8 projects have been completed within the Subprogram, all with significant outcomes. In June 2001, the FRDC approved the continuation of the RLEAS for a further 3 years through project 2001/211 with 7 new or continuing projects under management. A summary of all completed and current projects within the RLEAS is presented in this newsletter.

With the commencement of phase II of the RLEAS, we welcome Mr Larncé Wichman to the Steering Committee. The strong links the subprogram has developed with New Zealand researchers and the advanced state of rock lobster aquaculture in New Zealand compared with Australia prompted RLEAS to invite a New Zealand representative onto the Steering Committee. Larncé is Development Manager for Burkhart Fisheries Ltd, having previously



Left: Speakers at the 3rd annual RLEAS workshop

Below: The RLEAS Steering Committee and researchers travelling from Wellington to Picton, NZ



been Managing Director of Lobster NZ for 5 years.

April 2001 saw the subprogram head to Wellington, NZ for our third annual workshop. Co-hosted by the National Institute of Water and Atmosphere Research (NIWA) the event was successful in bringing scientists, fishermen and aquaculturalists together to discuss the future of rock lobster enhancement and aquaculture. The visit also gave the RLEAS Steering Committee a first hand glimpse of experimental rock

lobster grow-out being undertaken on commercial mussel farms.

Interest in work being undertaken within the RLEAS continues to grow. In September 2001 a number of participants in the Subprogram contributed to the program of the Second National Lobster Congress in



Greg Ward holds a cultured lobster

Geelong. In addition, I will be presenting an invited paper outlining the activities of the RLEAS and developments in rock lobster enhancement and aquaculture in Australia



Juvenile rock lobsters being grown on NZ mussel farms

and New Zealand at the World Aquaculture Society conference in Beijing, China in April this year.

In this issue of "Lob ReLEASE" we will provide a summary of research being conducted by Dr Michael Bruce and his colleagues in NZ on the

cultivation of spiny lobsters. We will also highlight some of the enhancement research being coordinated by Dr Caleb

Gardner and David Mills from the Tasmanian Aquaculture and Fisheries Institute as well as summarising the RLEAS strategic plan. As always, further information can be obtained by contacting me at rob@barneveld.com.au.



A typical NZ mussel farm in Marlborough Sound being used to assess the potential of rock lobster grow-out

Dr Robert van Barneveld
RLEAS Leader

RLEAS Workshop 2002...

The 2002 RLEAS workshop will be held in Cairns on May 29, 2002 at the Cairns Cruising Yacht Squadron. This year, the workshop will be a combined event co-hosted by the FRDC Rock Lobster Post Harvest Subprogram.

In addition to attending the workshop, delegates will have the opportunity to inspect the newly constructed Aquaculture and Stock Enhancement facility at the QDPI's Northern Fishery Centre. For further workshop details contact Kylie Franzmann at kylie@barneveld.com.au.

New Contact Details...

Please note the following changes in the contact details for the RLEAS.

Rock Lobster Enhancement and Aquaculture Subprogram

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Phone: 07 5547 8611

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Email: rob@barneveld.com.au

rleas@barneveld.com.au

New Subprogram Projects...

The FRDC Board approved 2 new projects within the RLEAS commencing on July 1, 2001. These projects compliment the five current projects underway within the Subprogram.

2001/094: Health assurance for Southern rock lobsters

Principal Investigator: Dr Judith Handlinger

(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Taroona, Tasmania, 7053)

Project Objectives:

- To undertake a health survey of representative groups of wild juvenile southern rock lobsters.
- To undertake similar examination of statistically relevant numbers of cultured rock lobsters of similar age to compare the prevalence of diseases with those found in wild stocks.

- To use the information acquired from the above in a risk analysis to determine the probability of adverse health consequences as a result of the release of cultured rock lobsters.
- To define protocols for health testing of juvenile rock lobsters before release.

2001/211: Strategic planning, project development and facilitation of research and extension towards the establishment and maintenance of rock lobster aquaculture and enhancement systems in Australia.

Principal Investigator: Dr Robert van Barneveld

(Barneveld Nutrition Pty Ltd, 19-27 Coonan Rd, South Maclean, Qld, 4280)

Project Objectives:

- Development and implementation of strategic plans and the facilitation of research and extension to assist the establishment of rock lobster aquaculture and enhancement systems in Australia.
- Coordination of a wide range of discipline-based (ie. nutrition, reproduction, husbandry) research projects across a range of rock lobster species relevant to different regions of Australia.
- Identification and procurement of funding from a variety of sources additional to FRDC to compliment or enhance existing rock lobster enhancement and aquaculture research in Australia and New Zealand.
- Identification and procurement of funding from a variety of sources to assist the commercialisation of technologies developed within RLEAS research program in partnership with the commercial sector and research agencies participating in the RLEAS.
- Facilitate the delivery of outcomes from the RLEAS in the form of annual workshops, newsletters, media releases, final reports, workshop proceedings and scientific publications.
- Provide a single point of contact for rock lobster enhancement and aquaculture research in Australia.
- Facilitate the functions of a RLEAS Steering Committee to ensure ongoing research programs have a high degree of industry relevance and focus.



Recently Completed Projects...

98/301: Rock Lobster Enhancement and Aquaculture Subprogram: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.

Principal Investigator: Dr Robert van Barneveld

(Barneveld Nutrition Pty Ltd, 19-27 Coonan Rd, South Maclean, QLD, 4280)

Final Report Status: A draft final report has been prepared for consideration by FRDC.

Outcomes: This project was successful in establishing a functional subprogram with inputs from a wide range of industry sectors. It convened a total of three workshops in Australia and New Zealand and forged the development of international research collaborations. By focusing research priorities, this project has ensured that the technology will exist for the development of Australian rock lobster enhancement and aquaculture systems.

Summary of Strategic Plan...

The Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) was established in July, 1998 with the following objective or "mission":

"To provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries".

It is important to note that the role of the RLEAS is not necessarily to promote aquaculture development, but to ensure the existing rock lobster industries have the capacity to pursue enhancement and aquaculture of rock lobsters if the net benefits clearly exceed any negative aspects. The Subprogram also ensures that the research and development program gives due consideration for the following:

- Protection of the wild fishery in terms of economic and social viability;
- Neutral or positive impact on the wild fishery in terms of stock numbers;
- Commercial viability of closing the life cycle of rock lobsters;
- Increasing profitability and wealth for Australasia.

The key research areas within the Subprogram are presented below:

- Species selection for aquaculture;
- Puerulus collection from the wild;
- Biological neutrality of wild stocks;
- Larval rearing/propagation of all species of rock lobsters;
- Nutrition of juveniles and adult lobsters;
- On-growing of juveniles and system requirements;
- Health of aquaculture reared juveniles;
- Economics and marketing;
- Enhancement of wild stocks through reseeded or resettlement.

At its last meeting in September 2001, the RLEAS Steering Committee re-addressed the following questions in an attempt to update the existing strategic directions:

- Where is the RLEAS going?
- What is the RLEAS looking for?
- Is the RLEAS over committed?
- Is the RLEAS meeting its objectives?

The outcomes from discussions based on these questions were as follows:

- The Steering Committee deemed the propagation question as still being critical and deemed that more outcomes from this research were required before additional strategic decisions could be made.
- A key target for the RLEAS was to derive technologies that allowed enhancement of rock lobster populations through aquaculture, and the maintenance of a rock lobster population in an aquaculture system.
- The Steering Committee decided to use and maintain the original RLEAS research priority list until more outcomes from propagation research were realized and a revised research direction could be formulated.

For information, the initial priority matrix established by the Steering Committee in relation to the allocation of funds was:

Broodstock	19%
Culture	30%
Wild Collection	14%
Ongrowing	16%
Enhancement	11%
Economics/Marketing	13%



The Steering Committee were able to further define some aspects of the RLEAS research priority list. Having completed research into puerulus collection and biological neutrality, it was made clear that enhancement of existing habitats to improve puerulus survival was still unresolved. It was also decided that the economics and marketing priority should be divided into two sections. Issues dealing with the costs of undertaking aquaculture activities and issues dealing with the impact of aquaculture products on existing markets, and markets for aquaculture products themselves. It was felt that those planning to undertake aquaculture activities are in the best position to define the costs and hence this should not form part of the RLEAS funding priorities. In addition, different states have different policies and directions as to where they want to go with aquaculture, and hence it is difficult to conduct research into this aspect that will be relevant for all areas.

The Steering Committee identified a number of additional areas that needed to be addressed by the RLEAS, including:

- Concern re the perception of aquaculture product vs wild product;
- Continued resistance from the wild fishery;
- Highlighting the fact that collecting puerulus will never be a serious industry;
- Puerulus are seen in Taiwan as an aquaculture product.

The Cultivation of Spiny Lobster in New Zealand – Larval Feeding Behaviour and Larval Nutrition.

Prepared by Dr Michael Bruce from the National Institute of Water and Atmospheric Research, NZ

Larval Feeding Behaviour

As well as studying the composition of diets for phyllosoma it is important to have a detailed understanding of how they capture and manipulate prey items. The addition of this kind of information to our knowledge base helps greatly in the development of diet formats and feeding regimes.

The feeding behaviour of instar 1, 2 and 3 phyllosomas was studied and recorded on video whilst they were fed on live or dead brine shrimps (Artemia). The phyllosomas exhibited a characteristic

tumbling behaviour prior to a random contact with an individual brine shrimp. To initiate a successful capture response, contact with the first or second legs (called pereopods 1 or 2) was necessary after which the brine shrimp would be transferred to the mouth via the maxillipeds (refer to Figure 1 for the definition of names). This response is shown in Figure 1 and followed a set sequence of events.

- Contact with pereopods 1 and 2
- Artemia brought to the mouth immediately with pereopods 1 and/or 2
- Manipulation usually occurs (degree of struggling and orientation, stage) - pereopods 1, 2 and 3 and maxilliped 3
- 1st bite usually to head of the Artemia (later phyllosoma instars - tail, trunk)
- Orientation - head typically upwards
- First bite occurred within 0-5 seconds
- Feeding involved pereopods 1 and 2 and maxilliped 3

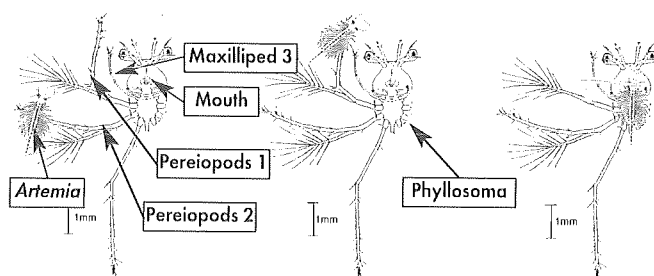


Figure 1. Sketch of the capture and manipulation technique of Artemia by *J. verreauxi* phyllosoma (adapted from Batham 1967)

Artemia were speared by the sharp, terminal dactyls present on the pereopods (Figure 2A) and passed forward to the mouth by the maxillipeds.

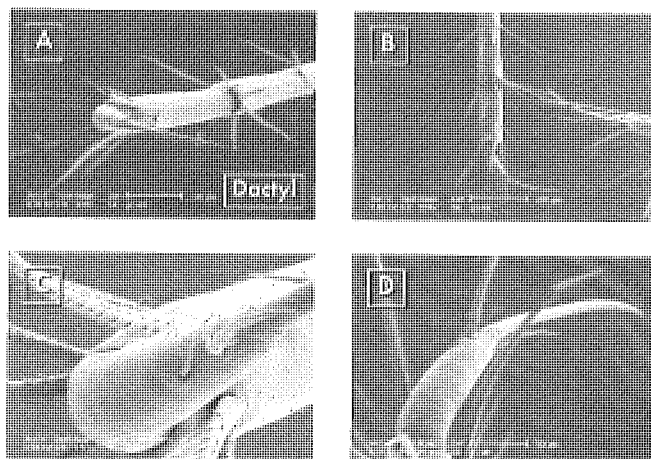


Figure 2. Scanning electron micrographs (SEM's) of pereopods 1 of *J. verreauxi* phyllosoma

Initial feeding activity consisted of shredding and tearing and was focused towards the head region of the Artemia. Phyllosoma usually positioned the Artemia longitudinally, in a head up orientation and limbs involved in the feeding process included the pereopods (1 and 2) and maxilliped 3 which served to push pieces of Artemia towards maxilliped 2 and maxillae 1. Scanning electron micrographs (SEM's) of pereopods 1 revealed a suite of mechano and chemosensory (Figure 2 & 3) receptors present on the pereopods (prominent hairs on the pereopods), which indicated that contact with prey is important in the capture process. Pereopods 3 had a lesser degree of receptive ability, which was reflected in the reduced dependency on this limb during feeding.

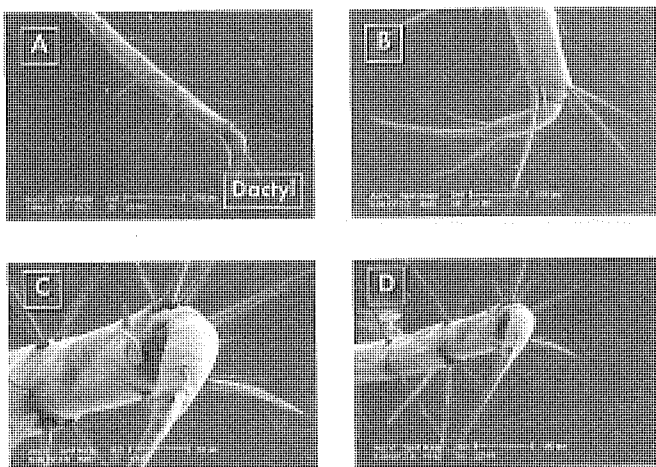


Figure 3. Scanning electron micrographs (SEM's) of Pereiopods 2 of *J. verreauxi* phyllosoma

Larval Nutrition

Work carried out at NIWA on the feeding behaviour and response to attractants has indicated that instar 1 and 2 phyllosomas rely on random encounters to capture prey but that phyllosomas as young as instar 3 (those that have been through 2 moult cycles) are able to actively pursue and capture prey and will accept inert diets. Several experiments have been carried out to examine alternative diet formulations and formats for rearing phyllosomas.

This section of the work was split in to two experiments. The aim of the first experiment was to determine the comparative effectiveness of live, in-house, and commercially formulated diets on the growth and performance of early instar *J. verreauxi* phyllosomas. A range of prepared diets were fed to instar 3 phyllosomas: an in-house formulated diet; a moist commercially formulated diet; a dry

commercially formulated diet; Algamac' enriched 2-3 day old Artemia; and a starved control.

The experiment was carried out on individual larvae (20 replicates of each treatment) held in mesh tubes in a water bath at 21 °C (after Tong et al. 1997). The larvae were selected at random prior to moulting to instar 3 from batches grown in upwelling tanks so that the moult to instar 3 gave a start date. When a larva moulted to instar 4 the timing was noted and it's length measured. Over the 19-day period of the experiment the only phyllosomas that moulted to instar 4 were those fed Artemia. Survival in this treatment was 80%, the inter-moult period was on average 10.6 days and they averaged 4.25 mm in length. Survival of phyllosomas fed manufactured diets was not noticeably different from the starved control. Observations during the experiment showed that the phyllosoma in the manufactured diet treatments avidly attached to and consumed all diets. Furthermore examination of the phyllosomas showed that they had good hepatopancreatic colour and did not show the breakdown of the hepatopancreas that was characteristic of the starved animals. However the performance of the phyllosomas on these diets, in terms of moulting and survival, was disappointing. It seems that manufactured diets did not fulfil the nutritional requirements of the phyllosomas to successfully moult to the next instar.

A second experiment on artificial diets was carried out in 25, 1-litre experimental tubes, each containing 20 similar-sized instar 6 phyllosomas. Larvae were selected from a batch grown in an upwelling tank immediately after a moulting cycle and were measured prior to being randomly assigned to the tubes. Each tube was serviced with 21 °C, 1 µm filtered seawater sprayed in at the surface and water was circulated from the bottom with gentle aeration. Water passed out of the tube at the bottom through two meshes, a 1500 mm cleaning screen attached to the bottom of the tube and a removable 400 mm feeding screen that fitted below the cleaning screen. Five diets were used: 3 mm Algamac enriched Artemia; small (5-10mm diameter) alginate Artemia "pizzas"; small gelatine/macerated mussel pizzas; small pearl pizzas (made with macerated mussel, Golden Pearl' prawn diet and gelatine); and mussel feed stations made by attaching the



gelatine/macerated mussel mix to strings which were suspended in the tubes. Once all phyllosomas had moulted to instar 7 the experiment was terminated and final measurements were made. Observations in the tubes showed that the phyllosoma were actively and avidly seeking, attaching to and consuming all the manufactured diets. Moulting and survival through one instar ranged from 45% for the mussel feed stations to 80% for the pearl pizza (although differences were not significant). Growth however did vary with diet, with the pearl pizza diet producing an average growth of 0.81 mm and all the other diets producing between 1.10-1.14 mm. Tubes fed the Artemia diets remained the cleanest, while the mussel diets were the dirtiest and this was reflected in the surface contaminating organisms of the phyllosomas. These results show promise, but now need to be extended through more instars in a longer-term experiment. Stability of the food, which is important in maintaining the cleanliness of the culture vessel, is likely to have a major impact on phyllosoma survival.

Trials of these diet formats/presentations have been carried out on later stage (instar 8-10) *J. verreauxi* phyllosomas in upwelling tanks with mixed results. Observations showed that the phyllosomas actively sought out the feed stations and within 5-10 minutes most were attached to and feeding on them. However these larger phyllosomas literally pulled the foods to pieces, stripping the strings within hours and creating a mass of debris in the tanks. This had a detrimental effect on the water quality in the recirculation system, on the cleanliness of the tanks, and ultimately on survival of the phyllosomas. The stability of the food and the feeding regime (amount, timing etc) are important variables that will need to be investigated.

References

Tong, L. J., Moss, G. A., Paewai, M. M., Pickering, T. D. 1997. Effect of brine-shrimp numbers on growth and survival of early-stage phyllosoma larvae of the rock lobster *Jasus edwardsii*. Marine and Freshwater Research 48, 935-40.

Publications...

RLEAS Publication No.1

- Rock Lobster Health Workshop: Current Status, Future Directions and Research and Development Priorities (\$11.00 inc GST)

Compiled by Assoc Prof Louis Evans, June 1998

RLEAS Publication No.2

- International Symposium on Lobster Health Management (\$22.00 inc GST)

Compiled by Assoc Prof Louis Evans, September 1999

RLEAS Publication No.3

- Technical Potential for Rock Lobster Propagation in Aquaculture Systems (\$22.00 inc GST)

Edited by Dr Piers R Hart and Dr Robert van Barneveld, August 2000

RLEAS Publication No.4

- Developments in Rock Lobster Enhancement and Aquaculture I (RLEAS Workshop 1999) (\$22.00 inc GST)

Edited by Dr Robert van Barneveld, March 1999

RLEAS Publication No.5

- Developments in Rock Lobster Enhancement and Aquaculture II (RLEAS Workshop 2000) (\$22.00 inc GST)

Edited by Dr Robert van Barneveld, April 2000

RLEAS Publication No.6

- Developments in Rock Lobster Enhancements and Aquaculture III (RLEAS Workshop 2001) (\$22.00 inc GST)

Edited by Dr Robert van Barneveld, April 2001

Other Publications

- Final Reports from projects: 98/300, 98/301, 98/302, 98/303, 98/304, 98/305, 99/314, 99/315 are available on request.

For a publication order form contact kylie@barneveld.com.au



Summary of Projects within the Rock Lobster Enhancement and Aquaculture Subprogram

1997 - 2004

Project	97-98	98-99	99-00	00-01	01-02	02-03	03-04
98/300 - Propagation of rock lobster - development of a collaborative national project with international partners.		•					
98/301 - Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.	•	•	•	•			
98/302 - Towards establishing techniques for large scale harvesting of pueruli and obtaining a better understanding of mortality rates.		•	•	•			
98/303 - Feed development for rock lobster aquaculture.		•	•				
98/304 - Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages.		•					
98/305 - Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out.		•	•				
99/314 - Preliminary investigation towards ongrowing puerulus to enhance rock lobster stocks while providing animals for aquaculture.			•				
99/315 - Propagation techniques.			•				
00/185 - Evaluating the release and survival of juvenile rock lobsters released for enhancement purposes.				•	•		
00/211 - Investigation into tail-rot necrosis in live-held adult lobsters.					•		
00/212 - The nutrition of juvenile and adult lobsters to optimise survival, growth and condition.				•	•	•	
00/214 - Advancing the hatchery propagation of rock lobsters.				•	•	•	
00/263 - Reducing rock lobster larval rearing time through hormonal manipulation.				•	•	•	
01/211 - Strategic planning, project development, and facilitation of research and extension towards establishment and maintenance of commercial rock lobster aquaculture and enhancement systems in Australia.					•	•	•
01/094 - Health assurance for southern rock lobsters.					•	•	

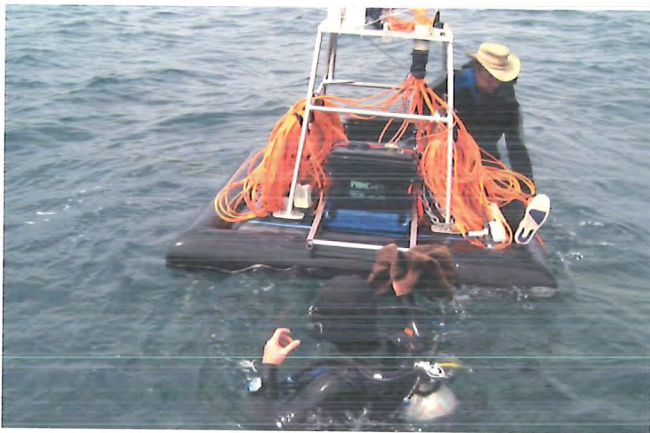


TAFI Release Juveniles Onto Reef

Research is under way in Tasmania to assess the feasibility of releasing aquaculture reared juveniles back to the wild. Pontoons and associated video gear necessary for the research were purchased using funding from the Ian Potter Foundation. This supports research funded by the FRDC Rock Lobster Enhancement and Aquaculture Subprogram on enhancement of coastal reefs with juvenile rock lobster. In this experiment Dr Caleb Gardner, David Mills and their colleagues deployed 6 video cameras, each with 2 infra red light sources. The unit transmits the signal of all six cameras back to shore where it is detected by a receiver and recorded to be viewed at a later date. The research at this site runs for 2 weeks before the gear is shifted to a different habitat. The video observations allow the researchers to evaluate what predators are responsible for mortality of juveniles in the first few days after release.



A juvenile lobster ready for release



Robbie Kilpatrick feeds video units down to the diver, Shane Fava, who deploys them in lobster dens on the reef below.



As cameras are deployed, Pip Cohen checks that a clear video signal of the juvenile lobsters is being transmitted.

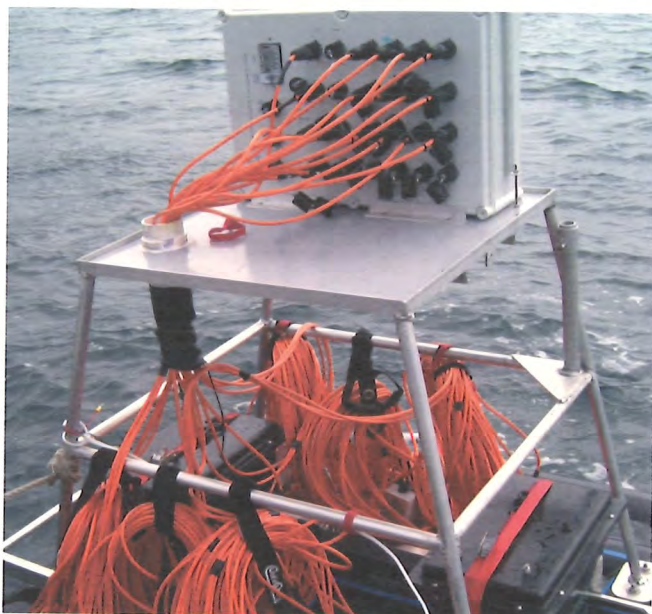


Tasmanian Aquaculture
& Fisheries Institute
University of Tasmania



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Six underwater video cameras and associated infra red lights are deployed simultaneously - which provides a lot of opportunity for tangles in the extensive array of cables.

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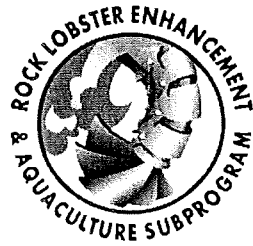
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Appendix 5 – Additional Publications



Rock Lobster Enhancement and Aquaculture in Australia

Revised by **Dr Robert van Barneveld**

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Potential for rock lobster aquaculture in Australia

The Australian rock lobster fishery is an important marine resource making up 25% of Australia's total fishery landings and presently worth around \$450 million per annum. However, while many are currently well managed, most Australian rock lobster fisheries are at their maximum sustainable capacity. Small increases in the value of production may be made in the future by increasing sales of live lobsters and/or targeting periods of high demand, but total gains are likely to be minimal. The real potential for significant growth appears to be through some form of aquaculture.

There is growing interest around the world in aquaculture of rock lobsters and this has recently extended to Australia. A number of States are investigating rock lobster aquaculture potential in various forms, the dominant methods including:

1. On-growing of adults through a moult to increase weight whilst allowing sale at periods of peak demand/ value,
2. On-growing of wild-caught puerulus (newly-settled juveniles) to a small (and potentially very valuable) market size of around 200-300 g, and
3. Culture of phyllosoma from eggs through the 11 larval stages to puerulus and subsequent on-growing to market size as above.

In addition, the potential exists through improved survival rates, for aquaculture to provide stock for reseedling and enhancement of the wild fishery.

In all cases there are many issues that require further research. Some specific aspects relevant to the various aquaculture and enhancement opportunities include:

Ongrowing of adults

Investigations into the on-growing of adult southern rock lobsters (*Jasus edwardsii*) have been ongoing since 1994, mainly in South Australia. The lobsters are held in cages at sea and are presently being fed with natural diets (trash fish/mussels). There is the potential to achieve weight gains of around 20% by growing the animals through the annual moult, representing a 60% return on investment. Some difficulties have been encountered with the renewal of leases for sea cages in South Australia, and hence interest in this form of aquaculture is changing focus to land-based raceway systems.

Ongrowing of wild-caught juveniles

In Tasmania (southern rock lobster, *J. edwardsii*), Western Australia (Western rock lobster, *Panulirus cygnus*) and Queensland (tropical spiny lobster, *Panulirus ornatus*) there is a growing interest in the potential for capturing wild puerulus and on-growing them to a small market size. The basis for this is that there is thought to be high mortality of wild puerulus in their first year post settlement (anywhere from 75-97%). However, recent results are showing that, if these animals are brought ashore and on-grown in tanks, the mortality is minimal (2% in Tasmania). Therefore the theory is that aquaculturists can on-grow the 'excess' that would have died in the wild. The animals are caught in collectors deployed at sea and quite large numbers have been caught in Tasmania.

A major issue associated with the on-growing of wild caught juveniles is how to compensate the wild fishery for their removal. This has been addressed in Tasmania after considerable discussion, by an agreement that 25% of all captured puerulus will be returned to the wild after one year of growth in captivity. This will ensure that there is no negative impact on the wild fishery and in fact, will probably lead to enhancement of the fishery. The success of this method obviously depends on the survival rate of released juveniles.

Culture of puerulus from eggs

Spiny rock lobsters have a complicated life cycle. The eggs hatch as tiny spider-like transparent larvae or phyllosoma. The phyllosoma drift in ocean currents for up to two years until they are ready to settle on a substrate and metamorphose into puerulus. The phyllosoma phase involves 11 distinct morphological stages and up to 17 moults (*J. edwardsii*). Culture of phyllosoma to puerulus has been successfully achieved in Japan and New Zealand in very small numbers. The phyllosoma can be fed on *Artemia* or chopped mussel flesh, but nutrition seems to be the major problem. The time to settlement can be greatly reduced in culture compared to that of wild larvae. In the long term, the culture of lobsters from eggs may prove to be the answer to the future sustainability of rock lobster aquaculture.

Rock lobster aquaculture and enhancement developments in Australia

Although there are a number of commercial groups on-growing adult rock lobsters, there is presently no commercial aquaculture of puerulus or larvae in Australia. Despite this, there is considerable interest across Australia in the establishment of rock lobster aquaculture enterprises. With this in mind, and given the recent developments in rock lobster aquaculture in other countries, the Fisheries Research and Development Corporation established the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) in July, 1998. The purpose of this Subprogram is to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive while operating in harmony with the wild fisheries.

A total of fourteen projects have now been funded under the auspices of the RLEAS. In the initial phases of the subprogram, research projects investigated a wide variety of topics including puerulus collection, "biological neutrality" and juvenile release, nutrition, health, system design and husbandry, and larval rearing. The subprogram has now consolidated with an increased focus on larval rearing (particularly the nutrition of phyllosoma), nutrition of juveniles to one year of age, the survival of aquaculture reared juveniles returned to the wild, factors influencing the incidence of tail fan damage in captive lobsters, and the hormonal manipulation of larval phases to reduce the length of the life cycle.

The RLEAS research program now represents an international collaboration between scientists in Australia and researchers at the National Institute of Water and Atmospheric (NIWA) Research in New Zealand. Rock lobster aquaculture in New Zealand has been underway for some years with a number of commercial enterprises in existence. Research conducted at NIWA has assisted the establishment of these enterprises and as a result, these scientists have a wealth of knowledge to contribute to the subprogram. In addition, involvement of New Zealand in the RLEAS has allowed the research to be extended to the "pack-horse" lobster (*J. verreauxi*) in addition to the more common commercial species in Australia.

Puerulus collection

Research in Western Australia and Tasmania has examined the development of collection methods for puerulus from the wild. Large 'fluffy' collectors set at different depths and in different areas off the Western Australian coast have been trialed with varying levels of success. This research has recently been extended to Tasmania where a number of different collector types on long lines are being examined. The Western Australian research has been hampered by low puerulus settlement, but has found that inshore collectors are more successful than those situated at a distance off shore. In Tasmania a survey of commercial aquaculture facilities has revealed some interesting spatial patterns of settlement on submerged structures while the research component has led to the development of suitable cost-effective collector types.

Biological neutrality

Historical data on the settlement of puerulus in specific areas in Western Australia has been used to assess the potential impact of puerulus removal on subsequent wild populations of adult lobsters. Extensive statistical analysis has been employed to assess a range of scenarios. Due to the sensitivity of the data and the potential implications of the results for both aquaculture and the wild capture fishery, the RLEAS Steering Committee is currently devising a strategy for release and dissemination of the information.

Nutrition

Nutrition research is being conducted on tropical, western and southern rock lobsters. All stages from early juveniles through to adults are being examined and cost effective manufactured diets are being evaluated. Recent work has shown that the protein content of diets for southern rock lobsters should be approximately 450 g/kg with lipid levels around 100 g/kg. The most noteworthy outcomes of nutrition experiments in all states to date are the apparent superiority of mussels over other diets and the distinct colour differences observed in lobsters fed different diets. It has been demonstrated that inclusion of approximately 100 mg/kg of carotenoids in southern rock lobster diets produces lobsters which are close to the natural colour of wild caught juveniles.

On-growing of juveniles

On growing of juvenile rock lobsters takes place in tanks and the animals grow best on a diet of fresh mussels. Artificial diets are readily accepted, but the growth and survival rates are not as good as with mussels. Despite this, artificial diets do support exceptional growth of southern rock lobsters if supplemented with mussels three times per week. Hides are placed in the tanks to reduce cannibalism that can occur at the moult. Under these conditions a marketable size can be reached in 2 years (Tasmania) or a weight of 500 g in 1 year (Queensland) with very low mortality levels.

System requirements

System design research is defining environmental requirements of juvenile and adult tropical and southern rock lobsters as well as identifying system design criteria for on-growing of adults. A recent experiment in Tasmania has shown that a temperature of 18-22° C is optimal for growth and survival of southern rock lobsters. Further research is required to identify optimal growing conditions in South Australia. Both dry and moist manufactured feeds have been examined as cheap alternatives to fresh mussels, yet cannibalism at the moult and a disease causing blackening and necrosis of the tail sections requires further attention.

Larval rearing

Research on propagation of the southern rock lobster in Tasmania has resulted in the successful culture through 10 of its 11 larval stages in around 9 months. The outcomes of an International

Workshop organised by the Tasmanian Aquaculture and Fisheries Institute through the Rock Lobster Enhancement and Aquaculture Subprogram suggest that the problems involved in larval rearing make it a risky proposition. However, economic and biological feasibility on a commercial scale do appear to be achievable. Subsequent research on the rearing of rock lobster phyllosoma suggests that the nutrition of these larval stages is limiting and new techniques need to be developed for the delivery and improved utilisation of feeds. It is hypothesised that nutritional status of the phyllosoma towards the end of their larval phases has a significant influence on settlement.

Enhancement of the wild fishery

As an adjunct to the above research in rock lobster aquaculture and enhancement, research underway in Tasmania is concentrating on the survival of wild caught on-grown juveniles after release back into the wild. Using electronic tagging methods released juveniles have been tracked for up to two weeks with no mortalities recorded.

Conclusions

Recent developments in rock lobster aquaculture and enhancement in Australia have resulted in an increased focus on the culture of rock lobsters from eggs to adults as the most sustainable form of aquaculture in the long term. Developments in the on-growing of wild caught puerulus and the enhancement of wild caught adults will assist development of the aquaculture sector in the short term, but both of these alternatives can be heavily influenced by the wild capture sector and the prevailing environmental conditions in any one year. Research underway within the RLEAS will provide the best chance of closing the life cycle of a variety of rock lobster species and will have a strong influence on the future of this industry in Australia and New Zealand.

Contact

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Appendix 6 – Annual Operating Plans

Rock Lobster Enhancement and Aquaculture Subprogram Annual Operating Plan - 2000

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BACKGROUND

The Australian rock lobster fishery is an important marine resource making up 25% of Australia's total fishery landings and presently worth around \$450 million per annum. However, while many are currently well managed, most Australian rock lobster fisheries are fully exploited. Small increases in the value of production may be made in the future by increasing sales of live lobsters and/or targeting periods of high demand, but total gains are likely to be minimal. The real potential for significant growth appears to be through some form of aquaculture.

There is growing interest around the world in aquaculture of rock lobsters and this has recently extended to Australia. A number of States are investigating rock lobster aquaculture potential in various forms, the dominant methods including:

4. On-growing of adults through a moult to increase weight whilst allowing sale at periods of peak demand/ value,
5. On-growing of wild-caught puerulus (newly-settled juveniles) to a small (and potentially very valuable) market size of around 200-300 g, and
6. Culture of phyllosoma from eggs through the 11 larval stages to puerulus and subsequent on-growing to market size as above.

In addition, the potential exists through improved survival rates, for aquaculture to provide stock for reseedling and enhancement of the wild fishery.

In all cases there are many issues that require further research. Some specific aspects relevant to the various aquaculture and enhancement opportunities include:

Ongrowing of adults

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Ongrowing of wild-caught juveniles

In Tasmania (southern rock lobster, *J. edwardsii*), Western Australia (Western rock lobster, *Panulirus cygnus*) and Queensland (tropical spiny lobster, *Panulirus ornatus*) there is some interest in the potential for capturing wild puerulus and on-growing them to a small market size. The basis for this is that there is thought to be high mortality of wild puerulus in their first year post settlement (anywhere from 75-97%) . However, recent results are showing that, if these animals are brought ashore and ongrown in tanks, the mortality is minimal (2% in Tasmania). Therefore the theory is that aquaculturists can ongrow the 'excess' that would have died in the wild. The animals are caught in collectors deployed at sea and quite large numbers have been caught in Tasmania.

This potential form of aquaculture is causing significant unrest within the wild fishing sector. A major issue associated with the on-growing of wild caught juveniles is how to compensate the wild fishery for their removal. There is also concern that scientists will not be able to accurately determine the number of puerulus that can be collected from the wild while maintaining biological neutrality.

The success of this method obviously depends on the survival rate of released juveniles. Despite some initial interest and following more detailed discussion most states are losing enthusiasm for this form of aquaculture, and it appears they would strongly prefer aquaculture systems based on a closed life cycle.

Culture of puerulus from eggs

Spiny rock lobsters have a complicated life cycle. The eggs hatch as tiny spider-like transparent larvae or phyllosoma. The phyllosoma drift in ocean currents for up to two years until they are ready to settle on a substrate and metamorphose into puerulus. The phyllosoma phase involves 11 distinct morphological stages and up to 17 moults (*J. edwardsii*). Culture of phyllosoma to puerulus has been successfully achieved in Japan and New Zealand in very small numbers. The phyllosoma can be fed on *Artemia* or chopped mussel flesh, but nutrition seems to be the major problem. The time to settlement can be greatly reduced in culture compared to that of wild larvae. In the long term, the culture of lobsters from eggs may prove to be the answer to the future sustainability of rock lobster aquaculture.

SUBPROGRAM ACTIVITY 1998-1999

Although there are a number of commercial groups on-growing adult rock lobsters, there is presently no commercial aquaculture of puerulus or larvae in Australia. Despite this, there is considerable interest across Australia in the establishment of rock lobster aquaculture enterprises. With this in mind, and given the recent developments in rock lobster aquaculture in other countries, the Fisheries Research and Development Corporation established the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) in July, 1998. The purpose of this Subprogram is to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive while operating in harmony with the wild fisheries.

The RLEAS currently consists of the following projects:

98/300: Propagation of rock lobster – development of a collaborative national project with international partners

Principal Investigator: Dr Piers Hart
(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

6. Identify potential for the development of commercial culture of rock lobster in Australia and determine the research and development potential required to achieve this potential.
7. Identify what resources (expertise, facilities, funds) are required to conduct the necessary research and development.
8. Identify potential international and national research and industry partners who are interested in collaborative research into culture of rock lobster from eggs.
9. Develop a research plan mapping out research and development projects, the collaborative partners, timelines and resources.
10. Submit a proposal to FRDC under the rock lobster enhancement and aquaculture subprogram.

Research on propagation of the southern rock lobster in Tasmania has resulted in the successful culture through 10 of its 11 larval stages in around 9 months. The outcomes of an International

Workshop organised by the Tasmanian Aquaculture and Fisheries Institute through the Rock Lobster Enhancement and Aquaculture Subprogram suggest that the problems involved in larval rearing make it a risky proposition. However, economic and biological feasibility on a commercial scale do appear to be achievable. Based on the outcomes of this workshop further research is underway which will concentrate on nutrition, system design and the hormonal mechanism of moulting in phyllosoma of tropical, western and southern rock lobsters (see 99/315)

98/301: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.

Principal Investigator: Dr Robert van Barneveld
(Barneveld Nutrition Pty Ltd, PO Box 42, Lyndoch, SA, 5351)

Project Objectives:

7. Coordinate the FRDC Rock Lobster Enhancement and Aquaculture Subprogram (applications, workshops, communication).
8. Conduct an annual research workshop to present research outcomes from the subprogram and to define research objectives for subsequent years.
9. Facilitate travel of the subprogram project Principal Investigators, a nominated industry representative and the Subprogram Leader to biannual scientific meetings.
10. Facilitate travel of industry representatives and the Subprogram Leader to biannual Steering and Management Committee meetings.
11. Coordinate the preparation of a subprogram newsletter, media releases and workshop publications.
12. Integrate with other FRDC and externally funded rock lobster research programs (eg FRDC Project 98/300 – Propagation of rock lobster – development of a collaborative national project with international partners and the FRDC Rock Lobster Post-Harvest Subprogram).

This project has been successful in establishing a Steering Committee and a strong degree of industry support. There is also a significant amount of coordination between projects, and the research priorities are being strongly conveyed to the research providers.

98/302: Towards establishing techniques for large-scale harvesting of pueruli and obtaining a better understanding of mortality rates

Principal Investigator: Dr Bruce Phillips
(Fisheries WA, WA Marine Research Laboratories, PO Box 20, North Beach, WA, 6020)

Project Objectives (Revised June, 1999):

4. To determine appropriate puerulus to legal size survival rates and potential harvesting ratios, that if implemented in the western rock lobster fishery, might result in “biological neutrality” being achieved.
5. To establish techniques for large scale harvesting of pueruli for rock lobsters.
6. To collaborate with scientists conducting puerulus collection research in Tasmania.

Research in Western Australia and Tasmania has examined the development of collection methods for puerulus from the wild. Large ‘fluffy’ collectors set at different depths and in different areas off the Western Australian coast have been trialed with varying levels of success. This research has recently been extended to Tasmania where a number of different collector types on long lines are being examined. The Western Australian research has been hampered by low puerulus settlement, but has found that inshore collectors are more successful than those situated at a distance off shore. In Tasmania a survey of commercial aquaculture facilities has revealed some interesting spatial patterns of settlement on submerged structures while the research component has led to the development of suitable cost-effective collector types.

98/303: Feed development for rock lobster aquaculture

Principal Investigator: Dr Kevin Williams
(CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

Project Objectives:

5. Review the state of knowledge of crustacean and fish nutrition of relevance to the development of formulated feeds for rock lobsters.
6. Develop a 'best guess' formulated diet for juvenile and adult rock lobsters (for tropical, *Panulirus ornatus*, western, *P. cygnus* and southern, *Jasus edwardsii* species) for comparative trialing against existing 'fresh' diet.
7. Determine the response of post-juvenile/young and adult rock lobsters to key nutrients critical for the development of cost-effective formulated diets for rock lobsters.
8. Make recommendations on the direction of future nutrition research.

Nutrition research is being conducted on tropical, western and southern rock lobsters. All stages from early juveniles through to adults are being examined and cost effective manufactured diets are being evaluated. Recent work has shown that the protein content of diets for southern rock lobsters should be approximately 450 g/kg with lipid levels around 100 g/kg. The most noteworthy outcomes of nutrition experiments in all states to date are the apparent superiority of mussels over other diets and the distinct colour differences observed in lobsters fed different diets. It has been demonstrated that inclusion of approximately 100 mg/kg of carotenoids in southern rock lobster diets produces lobsters which are close to the natural colour of wild caught juveniles.

On-growing of juvenile rock lobsters takes place in tanks and the animals grow best on a diet of fresh mussels. Artificial diets are readily accepted, but the growth and survival rates are not as good as with mussels. Despite this, artificial diets do support exceptional growth of southern rock lobsters if supplemented with mussels three times per week. Hides are placed in the tanks to reduce cannibalism that can occur at the moult. Under these conditions a marketable size can be reached in 2 years (Tasmania) or a weight of 500 g in 1 year (Queensland) with very low mortality levels.

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages

Principal Investigator: Assoc Prof Louis Evans
(Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

Project Objectives:

5. To establish a national network of rock lobster health and disease personnel.
6. To conduct a symposium on health and disease management in lobster aquaculture and long-term holding facilities
7. To collate and document current state of knowledge on rock lobster diseases.
8. To provide a disease diagnosis service for existing FRDC rock lobster projects in Queensland, South Australia and Western Australia.

This project resulted in the highly successful international symposium on rock lobster health held in conjunction with the Third International Rock Lobster Congress in Adelaide in September, 1999. The project also established a functional network of health research professionals.

98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out

Principal Investigator: Assoc Prof Mike Geddes
(University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

Project Objectives:

5. Assess the interactions between stocking density and feed delivery system on maintaining and improving condition and on the growth performance of adult rock lobsters in existing sea-based holding systems in different seasons.
6. Determine the effects of temperature, salinity and photoperiod on the growth rate and survival of juvenile rock lobsters in existing land-based holding systems.
7. Determine the effects of stocking density and shelter on the growth rate and survival of juvenile rock lobsters in existing land-based holding systems.
8. Evaluate existing system design and management regimes for land-based captive grow out of juvenile rock lobsters and for sea-based holding of adult rock lobsters.

System design research is defining environmental requirements of juvenile and adult tropical and southern rock lobsters as well as identifying system design criteria for on-growing of adults. A recent experiment in Tasmania has shown that a temperature of 18-22° C is optimal for growth and survival of southern rock lobsters. Further research is required to identify optimal growing conditions in South Australia. Both dry and moist manufactured feeds have been examined as cheap alternatives to fresh mussels, yet cannibalism at the moult and a disease causing blackening and necrosis of the tail sections requires further attention.

99/314: Preliminary investigation towards on-growing puerulus to enhance rock lobster stocks while providing animals for commercial culture

Principal Investigator: Mr Caleb Gardner

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

1. To develop methods to capture large numbers of 1 year old benthic juvenile rock lobsters, both for providing control animals and for monitoring survival of reseeded animals (note that this is not puerulus collection).
2. To determine the extent of movement of reseeded and control juveniles after release, to assist in estimation of survival.
3. To develop methods to assess relative survival of cultured juvenile lobsters released into a natural habitat.

Using electronic tagging methods released juveniles have been tracked for up to two weeks with no mortalities recorded.

99/315: Propagation techniques

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

1. Develop an artificial diet acceptable to phyllosoma of three species of rock lobster, that is water stable and easily manipulated through:
 - Characterising the morphology and function of the larval digestive system;
 - Examining the biochemical changes in cultured and wild phyllosoma;
 - Developing a best guess formulated diet for use in nutritional experiments;
 - Examining the suitability of diets for phyllosoma of rock lobster.
2. Examine mass culture systems and determine environmental requirements for phyllosoma of three species of rock lobster by:
 - Examining mass culture systems using southern rock lobster phyllosoma;

- Examining environmental requirements of southern rock lobster phyllosoma;
 - Examining environmental requirements of tropical rock lobster phyllosoma;
 - Examining the effects of temperature and food density on phyllosoma of the western rock lobster.
3. Develop hormonal control of moulting in rock lobsters by conducting a scoping study to examine the hormonal sequence controlling moulting in phyllosoma of a test species.
 4. Determine the health status of phyllosoma of southern rock lobster under culture conditions.

The value of research into rock lobster propagation may increase even further with advice that the new Victorian government is unlikely to support new marine based aquaculture enterprises and there is a strong preference for the development of land based aquaculture systems operating with a closed species life-cycle.

Subprogram Management and Operating Procedures

This Subprogram is highly responsive to the views of industry and understands the need to accommodate both the research requirements of the future and the needs of the existing wild fisheries and aquaculture industries.

To ensure that research conducted within the Subprogram is relevant and meets the above criteria, a Steering Committee has been established to:

- Provide industry feedback and views;
- Review existing research based on FRDC contractual obligations;
- Prioritise new proposals and provide a priority list for other agencies;
- Ensure outcomes are commercially focussed;
- Coordinate industry and research provider involvement - optimum use of resources;
- Facilitate extension and technology transfer.

Membership of the Steering Committee includes Robert van Barneveld (Chair), Patrick Hone (FRDC), Pheroze Jungalwalla (TAS), Neil Stump (TAS), Lionel Carrison (SA), Greg Ward (SA), Barry Spurrier (VIC), David Lucas (VIC), Jim Fogarty (QLD), Ian Finlay (WA), John Newby (WA), Peter Auguston (WA) and Bruce Phillips (FRDC Rock Lobster Post-Harvest Subprogram Leader).

The following points should be noted in relation to subprogram operation:

- The Steering Committee meets in March and September each year to review project progress and establish research priorities.
- Advice from the September Steering Committee is sent to all Fisheries Research Advisory Bodies so that they are aware of the subprogram research priorities.
- All new projects relating to rock lobster enhancement and aquaculture are assessed by the Steering Committee and are submitted to the FRDC Board via the subprogram.
- An annual subprogram workshop is held each March to extend research results to industry and researchers.

STRATEGIC PLAN

In the absence of a complete strategic research and development plan, the RLEAS Steering Committee members were asked to prioritise research areas independently. The following table summarises the outcome of this process.

No	Activity	Tas	Qld	Vic	SA	WA	FRDC	Mean
1	Broodstock and culture	60	75	45	35	40	45	50
2	Puerulus collection	3	5	15	13	20	10	11
3	On-growing	25	10	18	20	13	10	16
4	Enhancement	4	5	17	5	10	25	11
5	Economics and markets	8	5	5	27	17	10	12

The activities were based on the priority research and development categories identified to date as part of the strategic plan development process. It is apparent from the results, that while there are some differences in the perceived priorities between states, the general trend is the same. That is, broodstock and culture (ie propagation) has double the priority of all other research areas and there is little difference in priority between the remaining research categories. It is also apparent that a major gap that currently exists in submitted research proposals relates to the economics and marketing considerations.

Within the above priority research areas, the Steering Committee identified the following outcomes as critical to the success of the Subprogram:

- *Propagation*: The ability to produce puerulus from eggs from captive broodstock on a commercially viable scale. Propagation should focus on *P.ornatus* and *J.edwardsii*.
- *Live-holding/grow-out*: Identification of the factors that influence shell disease in *J. edwardsii* for juveniles and adults and can these factors be influenced in a management context. The research focus should be on prevention management.

Based on the above priorities and indicative budget allocations, the RLEAS Steering Committee is seeking key applications in the areas of:

- Broodstock and culture of rock lobsters;
- Live-holding and grow-out of rock lobsters
- Economics and marketing considerations for rock lobster products produced from aquaculture and the potential impacts on the wild sector.

Where possible, the Steering Committee would prefer large, integrated projects rather than several separate smaller projects.

The RLEAS Steering Committee believe that it is essential that any new projects actively incorporate researchers from New Zealand given the amount of research already completed in some areas that could significantly benefit the RLEAS.

Proposals on propagation of rock lobster are being sought following the completion of existing project 99/315, so that the results can be used for strategic direction.

It is important to note that the Steering Committee prioritised enhancement research within the Subprogram, however, given the benefits from this research that extend to the wild fishery, the Steering Committee feel it is appropriate to fund these projects outside the initial indicative funding allocation.

Communication and Technology Transfer

The Steering Committee has defined a policy for the distribution of information arising from research conducted within the Subprogram. The following guidelines will be applied when publishing research:

- Distribution of information must have a net benefit for the Australian industry.
- Dissemination of information to international partners will be approved when there is a two way flow of information.
- *Ad hoc* requests for results or information will not be accepted.
- Special cases for the supply of information will have to be approved by the Steering Committee and where appropriate, Memorandums of Understanding will be prepared.

The first annual workshop of the Rock Lobster Enhancement and Aquaculture Subprogram was held in Geraldton Western Australia on March 11, 1999. The workshop was well attended with more than 50 participants and included presentations from all Subprogram projects as well members of the rock lobster industry. Mr Daryl Evans from South Australian Mariculture shared his experiences with the establishment of aquaculture enterprises in Australia. One of the many outcomes from the workshop was the need to attempt to improve our understanding of the potential economic impact of the introduction of rock lobster aquaculture products into the market and how aquaculture and wild caught products can coexist in the market place.

An international symposium on lobster health management was held in Adelaide between September 19-21, 1999 and included information generated within the health component of the Rock Lobster Enhancement and Aquaculture Subprogram. The symposium was designed to encourage the exchange of ideas, information and knowledge between scientists and industry personnel on health management of lobsters and other commercially important crustaceans.

The Subprogram publishes an biannual newsletter called "Lob ReLEASE" (see header below). The newsletter is the principal industry communication of the subprogram and has received good feedback from all sectors of the rock lobster industry.



A number publications are available or are pending from the Subprogram including:

- Proceedings of a lobster health workshop held in Perth in July, 1998.
- Proceedings of the Rock Lobster Propagation workshop held in Hobart in January, 1999.
- Proceedings of the first annual RLEAS workshop held in Geraldton in March, 1999.
- A 5 year strategic research and development plan.

PROPOSED NEW RESEARCH

Five new research proposals were submitted for consideration by the RLEAS Steering Committee at their September meeting. Brief details of these projects are presented below:

1. Factors affecting the colour of Western rock lobsters, and exploring methods to hasten the colour change of tank held "whites" and "reds". Roy Melville-Smith, WA Fisheries.

- This project aims to identify which factors are responsible for giving white lobsters held under tank conditions, their most market acceptable colour and the biochemical causes leading to the pale colouration of white lobsters. Biochemical solutions will be investigated to accelerate the change in colour of tank held lobsters from white to a market acceptable red colouration.
 - The proposed cost of this project to the RLEAS would be \$485 754 between 2000/01 and 2002/03.
2. Live-holding and grow-out of juvenile and adult rock lobster. Assoc Prof Mike Geddes, University of Adelaide.
- This project represents a continuation of project 98/305.
 - The proposed objectives of this project are to:
 1. Improve the value adding performance of live-held adult southern rock lobster
 2. Reduce the incidence of tail fan damage in live-held adult southern rock lobster
 3. Optimise growth and survival of juvenile southern rock lobster
 4. Optimise growth and survival of juvenile tropical rock lobster.
 - The cost of this project to the RLEAS would be \$274 000 between 2000/01 and 2001/02.
3. Development of propagation techniques for Australian rock lobsters. Dr Piers Hart, Tasmanian Aquaculture and Fisheries Institute.
- The objectives of this project would be to continue research on propagation of rock lobster in those areas considered priorities after a review of the results from project 99/315.
 - No budget has been allocated to date.
4. Rock lobster fisheries enhancement and biological neutrality of puerulus harvest through reseeded. Dr Caleb Gardner, Tasmanian Aquaculture and Fisheries Institute.
- This project represents a continuation of the research commenced in project 99/314.
 - The proposed objectives of the project are to:
 1. Determine if juvenile lobsters, cultured from wild caught early juveniles, can be successfully released to the wild and provide a fisheries enhancement benefit.
 2. Identify and optimise factors which affect survival of reseeded juveniles.
 3. Determine the optimal age and size of reseeded juveniles that minimise the cost of culture while still achieving survival that provides an enhancement benefit.
 - The cost of this project to the RLEAS would be \$357 553 between 2000/01 and 2002/03.
5. Improved pelleted feeds for rock lobster aquaculture (A nationally-coordinated Australian rock lobster feed's development project. Dr Kevin Williams, CSIRO Marine Science.
- This project represents a continuation of project 98/303.
 - The proposed objectives of this project are to:
 1. Define the nutritional physiology and nutrient requirements of Australian rock lobsters necessary for the development of nutritionally-balanced, cost-effective diets.
 2. Develop highly attractive/palatable diets that stimulate food consumption in lobsters.
 3. Develop feeding strategies that optimise food consumption and which minimise food wastage.
 4. Extend project findings and facilitate their uptake by industry.
 - This project would cost the RLEAS \$793 671 between 1999/2000 and 2002/03.

The total funding requested from within new project proposals totals \$1,910,978 between 1999/2000 and 2002/03. This does not include funding for the propagation components of the research, funding for continual management of the Subprogram, or funding for projects that were not

submitted to the Subprogram prior to the Steering Committee meeting (and there are several from WA and NT). This total is well outside the budget for the Subprogram.

While each project may have had merit in its own right, and while most projects had support from the relevant FRABs, the RLEAS Steering Committee must consider the program as a whole relative to set objectives. It became quickly apparent that when considered collectively, the submitted research proposals lack cohesion and all require significant modification before they will be acceptable to the Subprogram. Hence, no projects were supported or prioritised in their current form.

All researchers were advised of the strategic directions developed by the Steering Committee and revised proposals were sought accordingly.

Based on Steering Committee feedback, three revised projects were submitted to the FRDC Board for consideration. Further modifications are required before these proposals will be acceptable to the Subprogram.

BUDGET

The RLEAS was established with an indicative budget of \$1.5 million over a three year period. This is a significant budget given the infancy of the industry, and to be maintained, there will need to be evidence of industry development arising from the research at some point. There will also need to be a demonstrated harmony with the wild fishing sector. In keeping with the initial budget allocation, RLEAS should not budget for more than \$500 000 per annum between 2001/02 and 2003/04. There is also a need to consider just how far ahead the Steering Committee wishes to plan given the rapidly changing priorities as more research is completed.

Examination of the current RLEAS expenditure reveals two things. Firstly, the bulk of the funding available has been expended in the first two years of the Subprogram. Secondly, a proportion of this initial allocation still exists (\$90,184).

To fund the short fall that will exist for new projects in 2000/01 (which is still within the initial 3 year period funded by FRDC), the following budget is proposed between 2000/01 and 2003/04. Note that this in no way guarantees that the funds suggested will in fact be granted by FRDC, but the RLEAS needs to establish some form of realistic goal before approaching the FRDC Board.

2000/01:	\$350,000
2001/02:	\$350,000
2002/03:	\$400,000
2003/04:	\$500,000+

It is not difficult to see that the requests for funds from new projects far exceeds the available funds. To this end, the Steering Committee established an indicative funding allocation based on priorities. The following will be used to develop new projects within the RLEAS:

Activity	Funding Year		
	2000/01 (\$)	2001/02 (\$)	20002/03 (\$)
Subprogram coordination	Existing	90,000	90,000
Propagation	200,000	150,000	200,000
Nutrition	Component	Component	Component
Health	Component	Component	Component
Live holding/on-growing	100,000	90,000	100,000
Economics and marketing	10-20,000	Pending	Pending
Puerulus collection	Existing	Review	Dependent
Enhancement (link to NZ)	Consider		
Contingency	20-30,000	20,000	10,000
TOTAL	350,000	350,000	400,000

The following should be noted in relation to the above indicative funding allocations:

- Those projects listed as components are discipline-based projects (ie nutrition and health) that will represent components within the core projects of propagation and live holding.
- Puerulus collection research will only be considered following review of the results from the existing projects.
- Enhancement research needs to be considered in the current year, but directions will depend on results from the existing project 99/314, and it is likely that funding will be sought outside the Subprogram.
- Every effort will have to be made to ensure that the extent of fund transfer between years is minimised.

BUDGET ADJUSTMENTS

Adjustments to Project 98/302

Following review of the first progress report from project 98/302 in March, 1999, the RLEAS Steering Committee requested a number of changes to the objectives of this project based on concerns with the overall project directions.

Dr Phillips and his collaborators responded appropriately to the requests made by the RLEAS Steering Committee. The project objectives were redefined and the overall budget was reduced to accommodate collaborative and parallel research with the Tasmanian Aquaculture and Fisheries Institute. Prior to ratification of the revised proposal by the RLEAS Steering Committee and approval by the FRDC Board, permission was granted for the expenditure of funds for salaries required to meet the redefined project objectives. The revised 98/302 objectives and budgets that were approved by the RLEAS Steering Committee in September, 1999 have been provided to FRDC.

Dr Bradley Crear from the Tasmanian Aquaculture and Fisheries Institute has prepared a research outline for puerulus collection research in Tasmania that compliments the research underway in Western Australia. This proposal has been prepared in consultation with Dr Bruce Phillips and has been supported by the RLEAS Steering Committee. The proposed budget of \$44 861 for this research fits within the original budget allocated for 98/302. A copy of this proposal has been provided to FRDC.

Based on the above, the RLEAS Steering Committee is seeking approval from the FRDC Board for the proposed adjustments to the budget and objectives of project 98/302 and for the inclusion of the proposed complimentary research to be conducted in Tasmania. The RLEAS Steering Committee recommend that the Tasmanian component of the research be included as part of project 98/302 and that FRDC facilitate the development of a sub-contract between WA Fisheries and the Tasmanian Aquaculture and Fisheries Institute for the completion of the research.

Adjustments to Project 98/305

Assoc Prof Mike Geddes requested an additional \$3 300.00 within project 98/305. This request was considered by the RLEAS Steering Committee at their meeting in March, 1999. The additional funds were for the assessment of a preferred rock lobster diet in outdoor tanks at West Beach in addition to the research completed to date. This was deemed worthwhile by the Steering Committee as the additional funds requested were reasonable given the total value of the project.

Before approving additional expenditure on salaries within project 98/305, the RLEAS Steering Committee sought clarification that the five staff members assigned to the project in the original submission had in fact undertaken their duties in the time allocated. Dr Geddes confirmed that all staff had worked on the project for the appropriate amount of time, and that their salaries had been expended. Approval is therefore sought from the FRDC Board for the additional funds for project 98/305.

All other projects are operating within their initial budgets.

Dr Robert van Barneveld
RLEAS Leader
December, 1999

Rock Lobster Enhancement and Aquaculture Subprogram Annual Operating Plan - 2001

Prepared by **Dr Robert van Barneveld**
Subprogram Leader

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A) ACTIVITY DESCRIPTION FOR 1999-2000

i) Sector Progress

Rock lobster enhancement and aquaculture is still in its infancy in Australia and New Zealand, but commitment to the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) and the strategic research directions of this subprogram have been ratified by recent developments in the industry.

- Negotiations continue between the wild capture sector and the Rock Lobster Grower's Association in Tasmania for the collection and on-growing of puerulus caught from the wild. The arrangement will include an agreement to return a fixed number of juvenile lobsters to the wild, but there is still considerable debate pending of how the process will be controlled and monitored. The benefits of reseeding vs quota buy-out have been outlined in Volume 1, Issue 2 of Lob ReLEASe.
- MG Kailis have entered a agreement with the Queensland Department of Primary Industries to conduct research into the propagation and grow-out of tropical rock lobsters. Where possible, outcomes from this research program are shared with the RLEAS, and close contact is maintained with researchers involved in the program.
- A number of investigations have been made into the live-holding and feeding of adult lobsters in South Australia with a view to value adding lobster products for sale in premium markets in Australia and overseas. To facilitate this, a continuous supply of lobsters in premium condition will be required. Pilot scale trials are planned early in the new year using recirculation systems.
- Live holding of adult lobsters in sea cages in South Australia has not progressed this year. A variety of reasons have been put forward for this, including a large supply of high priced lobsters negating the need to hold lobsters over until prices improve.
- Some progress is being made towards expanding existing land-based abalone aquaculture systems to include the grow-out of lobsters in South Australia. These groups are involved in research projects underway within the Subprogram.
- New Zealand continues to support a commercial rock lobster aquaculture industry based on a quota buy-out scheme. New Zealand researchers are now heavily involved in the RLEAS and will assist rapid progress towards research outcomes.

Overall, interest in rock lobster enhancement and aquaculture remains high, but as with many emerging aquaculture industries, constraints imposed by regulators and planning authorities is slowing development of the industry.

ii) Major research outputs of the subprogram

A number of Subprogram projects have now been completed. A short summary of the outcomes from some of these projects and the status of final reports is presented below. Copies of final reports that have been accepted by FRDC can be obtained from the Subprogram Leader.

98/300: Propagation of rock lobster – development of a collaborative national project with international partners

Principal Investigator: Dr Piers Hart
(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: A final report in the form of workshop proceedings has been accepted by FRDC.

Outcomes: The outcome of the workshop was that, while many questions remain unanswered, sufficient information is currently available to suggest that rock lobster propagation is not only practically feasible, but there are strong indications that a rock lobster hatchery could be commercially viable. On this basis, it was agreed that a research and development plan should be pursued and a funding application submitted to FRDC for an initial 1 year research project with an expectation of a longer and more elaborate project to follow. These recommendations were obviously endorsed with these two projects subsequently being funded by FRDC.

98/303: Feed development for rock lobster aquaculture

Principal Investigator: Dr Kevin Williams
(CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

Final Report Status: Draft final report submitted for consideration by the Steering Committee and FRDC.

Outcomes: This project has addressed a range of issues associated with the nutrition of juvenile and adult lobsters including the successful development of manufactured feeds for captive lobsters.

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages

Principal Investigator: Assoc Prof Louis Evans
(Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

Final Report Status: Pending

Outcomes: A lobster health network was successfully established as part of this project and an international symposium on lobster health management was convened in conjunction with the Third International Lobster Congress in South Australia.

98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out

Principal Investigator: Assoc Prof Mike Geddes
(University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

Final Report Status: Draft final report submitted for consideration by the RLEAS Steering Committee and FRDC.

Outcomes: Outcomes from this project will allow aquaculturalists, rock lobster fishers and processors to make better informed decisions about holding systems, holding times, feeding regimes, feed types and selection of lobsters and long term live-holding of *Jasus edwardsii*. In addition, the

project has defined temperature, salinity and density optima for the tank culture of *P. ornatus*, basic production protocols for *P. ornatus*, and the commercial aquaculture potential of *P. ornatus*.

99/314: Preliminary investigation towards ongrowing puerulus to enhance rock lobster stocks while providing animals for commercial culture

Principal Investigator: Dr Caleb Gardner

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: Draft final report submitted for consideration by the RLEAS Steering Committee and FRDC.

Outcomes: Survival results from this project are encouraging for the future of reseeding aquaculture grown juveniles, however, caution is urged in their interpretation. There is evidence that survival varies greatly between habitats and/or regions, and seasonal effects are also likely. Most importantly, this study has shown that obtaining accurate estimates of short term survival of juvenile lobsters is both possible and practical. There is confidence that results from the model, and new knowledge on juvenile lobster movement can be used to design a robust study to predict likely survival of reseeded lobsters across habitats, geographic regions and seasons.

99/315: The development of rock lobster propagation techniques for aquaculture in Australia

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: Pending

Outcomes: The results from this project have begun the construction of a picture of phyllosoma development over time, which can be related to the structure of a potential culture technology. This information has been used to develop a further submission to FRDC for continued research into the propagation of lobsters with a focus on nutrition.

iii) Related projects and research linkages

A number of related research programs not funded by FRDC have direct relevance and linkages to the RLEAS.

The first involves the Queensland Department of Primary Industries and MG Kailis. Funds in the vicinity of \$150,000 per annum are being invested by MG Kailis into the propagation and grow-out of tropical rock lobsters. The research objectives are closely aligned with those of the RLEAS and where possible research outcomes are shared. Dr Clive Jones from QDPI is in regular contact with other researchers involved in the RLEAS, and Mr James Fogarty from MG Kailis represents the Queensland sector on the RLEAS steering Committee.

The RLEAS has actively involved the National Institute of Water and Atmospheric (NIWA) Research in the research program. This is to allow the RLEAS to take advantage of the existing research program and investment underway into rock lobster enhancement and aquaculture in New Zealand. NIWA currently spends in the vicinity of \$AUD600,000.00 on lobster aquaculture and enhancement research as follows:

Aquaculture: The current focus of New Zealand aquaculture research is in developing the ability to raise juvenile lobsters from eggs in captivity. They have now succeeded in doing so in small numbers for two species of lobsters, but still need to work out the methods for raising large numbers more cost effectively. The upwelling larval cultivation system developed in New Zealand has now been adopted by many researchers working in this area in Australia.

New Zealand currently has a small lobster on-growing industry based on the collection of juvenile lobsters from the wild fishery. Much of their recent research has been in finding effective methods for catching large numbers of these small lobsters and finding more cost effective methods for on-growing them. This has included the development of manufactured diets and a range of new culturing methods, including sea cages and land-based techniques.

Enhancement: There are excellent opportunities for the enhancement of the wild lobster fisheries in New Zealand. Unfortunately, little is known about the effectiveness of different enhancement techniques. Therefore, enhancement research is focussed in three key areas; enhancing reproductive output, enhancing early juvenile survival, and release of on-grown juvenile lobsters to the wild.

It is clear that New Zealand has a lot of common interests with Australia in the area of lobster enhancement and aquaculture. Developing strong research linkages between the two countries will have significant mutual benefits in these areas of research which are complex and relatively costly. NIWA has already begun providing expertise and logistic support to a number of Australian lobster research initiatives, and these initial overtures are now being reciprocated.

iv) Role RLEAS has played in industry development

Via the Subprogram Leader and the Steering Committee, the RLEAS has attempted to have an active role in all industry developments to date, either through providing research outcomes to support industry development, or by providing direct assistance with the procurement of funds or strategies to assist industry development.

v) Operating procedures

This Subprogram is highly responsive to the views of industry and understands the need to accommodate both the research requirements of the future and the needs of the existing wild fisheries and aquaculture industries. To ensure that research conducted within the Subprogram is relevant and meets the above criteria, a Steering Committee has been established to:

- Provide industry feedback and views;
- Review existing research based on FRDC contractual obligations;
- Prioritise new proposals and provide a priority list for other agencies;
- Ensure outcomes are commercially focussed;
- Coordinate industry and research provider involvement - optimum use of resources;
- Facilitate extension and technology transfer.

Membership of the Steering Committee includes Robert van Barneveld (Chair), Patrick Hone (FRDC), Pheroze Jungalwalla (TAS), Neil Stump (TAS), Lionel Carrison (SA), Greg Ward (SA), Barry Spurrier (VIC), David Lucas (VIC), Jim Fogarty (QLD), Ian Finlay (WA), John Newby (WA), Peter Auguston (WA) and Bruce Phillips (FRDC Rock Lobster Post-Harvest Subprogram Leader).

The Steering Committee meets in March and September each year to review project progress and establish research priorities. Advice from the September Steering Committee is sent to all Fisheries Research Advisory Bodies so that they are aware of the subprogram research priorities. All new projects relating to rock lobster enhancement and aquaculture are assessed by the Steering Committee and are submitted to the FRDC Board via the subprogram.

Improved operating procedures for the RLEAS have been proposed in a current submission to FRDC for ongoing coordination of the RLEAS. A summary of these procedures is presented below:

Industry consultation and communication: The Subprogram Leader, Dr van Barneveld, will continue to promote the activities of the RLEAS through a website, industry newsletters, and direct communication with industry organisations and representatives. Heavy reliance will be placed upon

ongoing maintenance of the Steering Committee with representatives from the rock lobster wild fishing sectors and the aquaculture sectors across Australia for the provision of strategic direction and advice.

Strategic planning: Strategic planning for the RLEAS will be based on outcomes from the existing research program and ongoing consultation between the Subprogram Leader and members of industry and researchers in Australia and New Zealand. The strategic plan will be maintained and updated annually using CD-ROM for distribution. The strategic planning process will identify those factors that represent restrictions to the initial establishment of rock lobster aquaculture (eg. propagation, nutrition) and enhancement (eg. monitoring survival, prevention of disease introduction to the wild fishery) processes, and then will utilise a relative ranking score from the various rock lobster fisheries across Australia.

Communication with FRABS: Communication with FRAB's will be via distribution of an annual operating plan for the RLEAS in December of each year combined with direct communications. The Subprogram Leader will also attend the annual FRDC FRAB workshop to promote the activities and objectives of the RLEAS.

Development of new research proposals: New research proposals will be developed through the use of facilitated strategic planning meetings. Using priorities published in the RLEAS Strategic Plan, the Subprogram Leader will convene meetings with relevant researchers and research institutions to:

1. Define the planned outcomes of the new proposal;
2. Manage an indicative budget for the research as defined by the Steering Committee;
3. Identify which researchers/institutions are best placed to undertake the research;
4. Promote collaboration between researchers and institutions where appropriate;
5. Seek external expertise and inputs as required.
6. Ensure the new proposal meets the objectives of the subprogram and that the research remains relevant and focussed.

The Subprogram Leader will ensure new research proposals are distributed to FRABS and the RLEAS Steering Committee for comment and ratification before submitting the proposals to FRDC on behalf of the lead agencies, or facilitating adjustments to the proposals prior to submission.

Coordination of research reports: The Subprogram Leader will collate progress and final reports from projects within the Subprogram in March and September each year for delivery in a common format to FRDC. These reports will be distributed to members of the Steering Committee for comment and review.

Review of research progress and direction: The RLEAS Steering Committee will interview the Principal Investigator of each project within the Subprogram twice annually as part of the Steering Committee meeting. Principal Investigators will be expected to report progress against contracted milestones, justify any changes in research direction, and demonstrate the research program is making a valuable contribution towards the achievement of the subprogram objectives. The Steering Committee will make recommendations to the FRDC Board in relation to potential changes to the objectives of the research program, or instances where project progress is unsatisfactory.

Coordination of research extension: A major function of the Subprogram Leader will be the organisation and delivery of an annual research workshop to highlight the activities and outputs of the RLEAS. Workshops will be convened with presentations from invited speakers and researchers aimed at delivering key messages to end-users for use in practical rock lobster aquaculture and enhancement systems.

The Subprogram Leader will compile a subprogram newsletter "Lob ReLEASE" at least annually or as required highlighting research outcomes, developments in rock lobster enhancement and aquaculture and events relevant to the RLEAS. The Subprogram Leader will also be responsible for the approval

of all media releases and scientific publications arising from research projects within the Subprogram using the RLEAS Steering Committee communication policy as a guide.

Collaboration with international partners: The Subprogram Leader has already established a major international collaboration between researchers in Australia and New Zealand through project 98/301. This was achieved through direct interaction with researchers in New Zealand and involvement of these scientists in the RLEAS research program. There is further opportunity to build on relationships initiated with Japanese researchers by AIMS, CSIRO and TAFI as the RLEAS continues to evolve. In all cases, international collaborations will be based on a two-way flow of information and where possible, research funds.

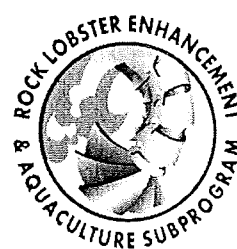
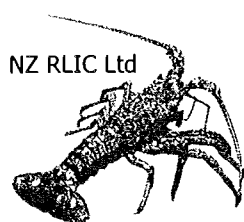
Identification and procurement of additional funding: Additional funding from sources such as the Public Good Science Fund in New Zealand and AUSIndustry in Australia will be procured with the assistance of the Subprogram Leader and relevant end-users. The Subprogram Leader is already involved with the development of AUSIndustry COMET proposals for the commercialisation of existing technology for rock lobster aquaculture. There are also opportunities for commercial investment in the development of technologies for rock lobster aquaculture in conjunction with the existing research program. For example, interest has been expressed in the commercial development of rock lobster feeds and rock lobster tank systems.

Liaison with FRDC: The Subprogram Leader will be the conduit for communications between FRDC and subprogram participants in relation to project contracts, project reports, new submissions and general correspondence. The Subprogram Leader will also represent the RLEAS at the annual FRDC FRAB and Subprogram meetings in Canberra.

vi) Meetings and Workshops

The RLEAS has now convened two national workshops, has hosted a lobster health workshop in Western Australia, a lobster propagation workshop in Tasmania, and an international symposium on lobster health management in South Australia in conjunction with the Third International Lobster Congress. Steering Committee meetings are held in March and September each year. Facilitated planning meetings are convened as required throughout the year.

Proposed details of the next RLEAS Workshop to be held in conjunction with the New Zealand Rock Lobster Industry are presented below:



A Sharing of Knowledge: Australasian Rock Lobster Research

“He tutu kaka kai uta, he toka koura ki te moana”

Large, healthy and sustainable lobster fisheries are an important feature of both Australia and New Zealand. Managing and further developing these resources relies heavily on credible scientific information and the exchange of that information. The sharing of the latest in scientific information on lobster resources is the theme for a workshop to be held in Wellington, from 2 – 6 April 2001.

The first two days of the workshop will be a showcase of *Jasus* lobster research currently being undertaken in New Zealand, with researchers gathered from all over the country. This will be followed by the annual meeting of the Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS), with presentations from researchers from both sides of the Tasman on *Jasus* and *Panulirus* production. Following the meeting there will be opportunities for participants to visit lobster research, processing and farming sites. All are encouraged to attend both meetings.

The meetings will be held at Te Papa – the Museum of New Zealand on Wellington's waterfront. It is a world-famous museum, with a reputation for being modern, entertaining, and interactive. See www.wellington.com.nz and www.tepapa.govt.nz for more information.

Tentative Schedule

New Zealand Jasus Lobster Research Showcase – Hosted by the NZ Rock Lobster Industry Council

2 April, 2001

Registration followed by welcome and keynote address

Sessions through until 5pm covering topics:-

Reproductive biology and behaviour, oceanic and larval processes, juvenile benthic and recruitment processes, habitat and enhancement, ecosystem biodiversity

3 April, 2001

Sessions through until 5pm covering topics:-

Fisheries management, customary management and practice, fishery practice, technology, physiology and product quality

Rock Lobster Enhancement and Aquaculture Subprogram - Hosted by NIWA

4 April, 2001

Sessions through until 5pm covering topics:-

Larval propagation, nutrition, enhancement, live holding

5 April, 2001

Meeting of RLEAS steering committee with concurrent planning meetings of RLEAS research project groups.

6 April, 2001

RLEAS group meeting to discuss common outcomes from the planning meetings.

After 10am visits to local research and lobster processing facilities and further afield to lobster aquaculture sites should there be sufficient demand.

vii) Summary of current project status

The FRDC Board approved five new projects within the RLEAS commencing on July 1, 2000. The projects were based on priorities and directions defined by the RLEAS Steering Committee using outcomes from research completed to date and identified limitations to the future development of rock lobster enhancement and aquaculture systems. The projects are consistent with the Subprogram mission "to provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries".

2000/185: Evaluating the release and survival of juvenile rock lobsters released for enhancement purposes

Principal Investigator: Dr Caleb Gardner
(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

1. To develop release protocols to minimise mortality based on the anti-predator behaviour of wild and cultured juvenile *J. edwardsii*.
2. To provide recommendations on release (micro) habitats for optimising the benefit of enhancement operations.
3. To evaluate the conclusions of objectives 1 and 2 in pilot scale enhancement experiments.

2000/211: Investigation into tail rot necrosis in live-held adult rock lobsters

Principal Investigator: Assoc Prof Mike Geddes
(University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

Project Objective:

1. Identify potential causes of tail fan necrosis in live-held adult southern rock lobster.
2. Provide advice on possible preventative methods for reducing the incidence of tail fan necrosis in live-held adult southern rock lobster.

2000/212: The nutrition of juvenile and adult lobsters to optimise survival, growth and condition.

Principal Investigator: Dr Kevin Williams
(CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

Project Objectives:

1. Develop manufactured feeds for juvenile rock lobsters (ie puerulus – year 1 and beyond) that optimise survival and growth by a) defining the chemico-physical cues that stimulate food consumption in juvenile rock lobsters, b) developing pelleted feeds that remain attractive to lobsters for periods in excess of four hours after immersion, and c) determining the optimum dietary specifications of selected nutrients required by juvenile rock lobsters for growth and development.
2. Develop manufactured feeds for adult lobsters for body maintenance and moult manipulation by a) determining the optimum pellet size and feeding frequency for maintaining the condition of adult rock lobsters and b) providing continued advice to project 98/305 on lobster feeds development for adult lobster holding.

2000/214: Advancing the hatchery propagation of rock lobsters

Principal Investigator: Dr Bradley Crear
(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Project Objectives:

1. To demonstrate that nutrient supply is a limiting factor in the growth and survival of rock lobster phyllosoma by the identification of a) which nutrients are critical, b) which nutrients are rock lobster phyllosoma adapted to digest, and c) whether we can manipulate growth through manipulation of nutrient supply.
2. To reduce the reliance on live feed for rearing of rock lobster phyllosoma by the identification of a) what stimuli are required to make formulated diets more attractive to phyllosoma, and b) what factors influence the consumption of formulated diets.

2000/263: Reducing rock lobster larval rearing time through hormonal manipulation

Principal Investigator: Dr Mike Hall
(Australian Institute of Marine Science, Marine Biotechnology, PMB No 3, Townsville Mail Centre, Qld, 4810)

Project Objectives:

1. To identify hormonal triggers for moulting to evaluate a shortening of the larval phase.

B) SUMMARY OF STRATEGIC PLAN

The following outcomes remain critical to the success of the Subprogram and the future of rock lobster enhancement and aquaculture:

- *Propagation:* The ability to produce puerulus from eggs from captive broodstock on a commercially viable scale. Propagation should focus on *P.ornatus* and *J.edwardsii*.
- *Live-holding/grow-out:* Identification of the factors that influence shell disease in *J. edwardsii* for juveniles and adults and can these factors be influenced in a management context. The research focus should be on prevention management.

Now that the RLEAS is reaching the end of its first phase, a more detailed strategic plan will be prepared based on outcomes from completed and existing research projects.

At present, a large number of the research priorities identified by the RLEAS Steering Committee are being addressed. Exceptions to this include:

- Economics and marketing considerations for rock lobster products produced from aquaculture and the potential impacts on the wild sector.

C) Communication and technology transfer

The Steering Committee has defined a policy for the distribution of information arising from research conducted within the Subprogram. The following guidelines will be applied when publishing research:

- Distribution of information must have a net benefit for the Australian industry.
- Dissemination of information to international partners will be approved when there is a two way flow of information.
- *Ad hoc* requests for results or information will not be accepted.
- Special cases for the supply of information will have to be approved by the Steering Committee and where appropriate, Memorandums of Understanding will be prepared.

The Subprogram publishes an annual newsletter called "Lob ReLEASE". The newsletter is the principal industry communication of the subprogram and has received good feedback from all sectors of the rock lobster industry.

A number publications are available or are pending from the Subprogram including:

- Proceedings of a lobster health workshop held in Perth in July, 1998.
- Proceedings of the Rock Lobster Propagation workshop held in Hobart in January, 1999.
- Proceedings of the first annual RLEAS workshop held in Geraldton in March, 1999.
- Proceedings of the second annual RLEAS workshop held in Hobart in February, 2000.

- Final reports from completed projects.
- "Lob ReLEASE" Volume 1, Issues 1 and 2.
- Scientific publications from completed and existing research projects.

D) PROPOSED NEW RESEARCH

Four new proposals were considered by the RLEAS Steering Committee at their last meeting on November 6, 2000.

1. Rock Lobster Enhancement and Aquaculture Subprogram: Strategic planning, project development, and facilitation of research and extension towards the establishment and maintenance of rock lobster enhancement and aquaculture systems in Australia. Dr Robert van Barneveld, Barneveld Nutrition Pty Ltd.

Priority: High. This project was viewed as critical to the ongoing success of the Subprogram. It received support from the SA FRAB and the Steering Committee and has been sent to all other FRABS for information. It has been submitted to FRDC as a full application by the Subprogram.

2. Can production in the Southern rock lobster fishery be improved? Linking juvenile growth, survival and density dependence to sustainable yield. Dr Stuart Frusher, TAFI.

Priority: N/A. This project was viewed as having linkages with the RLEAS via methodology. It was viewed as pure science rather than having any commercial relevance with very ambitious objectives. The project was viewed as having some benefits in relation to the RLEAS but was not seen as a core project. If the project did proceed, then the RLEAS would be keen to foster linkages with project 2000/185.

3. Further studies into puerulus collection and biological neutrality in Western Australia. Prof, Bruce Phillips, Curtin University of Technology.

Priority: State-based. In the first phase of the RLEAS, biological neutrality was a core component of the research. Outcomes from project 98/302 suggest that the vast numbers of puerulus available for capture in the fishery are unlikely to be affected by the removal of puerulus for on-growing within the viable limits of commercial collection. Further to this, it is clear the research is highly site specific and highly dependent on the quality of historical data. To this end, while research of this nature would be managed by the RLEAS, the Steering Committee felt that research of this nature was no longer a core component of the Subprogram, reserved comment on the proposal and decided to accept comments made by the WA FRAB in relation to the project

4. Development of health assurance procedures for aquaculture reared lobsters that may re-enter the wild fishery. Dr Judith Handlinger, Tasmanian Aquaculture and Fisheries Institute.

Priority: State-based. A full copy of this proposal was not available for perusal by the Steering Committee, but the objectives and outcomes were provided by Pheroze Jungalwalla at the meeting. This project is an integral adjunct to negotiations currently underway in Tasmania in relation to the development of an aquaculture industry based on collection of puerulus from the wild with an agreement to reseed a proportion of the on-grown juveniles. Obviously, the health status of the reseeded juveniles is of concern to the wild capture sector, and hence mechanisms must be developed to ensure the health status of these animals. Again, while research of this nature would be managed by the RLEAS, the Steering Committee felt that research of this nature was highly specific to Tasmania, reserved comment on the proposal and decided to accept comments made by the Tasmanian FRAB in relation to the project

E) WORKPLAN FOR THE NEXT 12 MONTHS

Workplans have been developed for the first 12 months of each project. As most of these projects are very large in nature with a number of collaborators, it is not possible to include detail in this document. If further information is required on the workplans for each project, the Subprogram Leader can provide this information from the Steering Committee minutes.

F) BUDGET

The RLEAS was established with an indicative budget of \$1.5 million over a three year period. In keeping with the initial budget allocation, the RLEAS Steering Committee has allocated not more than \$500 000 per annum between 2001/02 and 2003/04. They have developed their priority projects within this budget, however, it should be noted that FRDC has allocated additional funds from 2000/2001 to the Subprogram in the form of Project 2000/263. The Steering Committee has closely monitored the budget to account for a disproportionate expenditure within the first two years of operation.

With the above in mind, the following indicative budget allocation is still relevant:

Activity	Funding Year		
	2000/01 (\$)	2001/02 (\$)	20002/03 (\$)
Subprogram coordination	Existing	100,000	100,000
Propagation	200,000	150,000	200,000
Nutrition	Component	Component	Component
Health	Component	Component	Component
Live holding/on-growing	100,000	90,000	100,000
Economics and marketing	10-20,000	Pending	Pending
Puerulus collection	Existing	Review	Dependent
Enhancement (link to NZ)	Consider		
Contingency	20-30,000	10,000	-
TOTAL	350,000	350,000	400,000

G) Variations

A variation in milestones has been requested by Dr Michael Bruce from NIWA in relation to project 2000/214. Details of this request are presented below:

In April of this year some preliminary work on attractants in phyllosoma feeds was carried out by NIWA to allow us to outline the experimental system as included in section B11, 2.1 of the FRDC contract. We obtained some initial indicators of some of the chemical (principally amino acids) stimulants that attracted phyllosoma to food items. The interesting results from this work needed to be further developed and repeated which we intended to do in the Winter next year when we again have late stage phyllosoma.

The milestone states that this work would be completed by the end of December this year which is impossible as the packhorse lobsters only start releasing larvae later in the season. This detail was adjusted in one of the proposals received by NIWA, but as there were several, it is not surprising that the amendment was missed in the final version.

Therefore, NIWA would like to request that milestone 31-Dec-00 be amended from:

31-Dec-00: Assessment of dietary attractants for late stage *J. verreauxii* phyllosoma completed (NIWA)

To:

31-Apr-01: Assessment of dietary attractants for late stage *J. verreauxii* phyllosoma completed (NIWA)

The results of our initial work earlier this year will be included in our initial report to you at TAFI in January 2001.

Recommendation: That this request be accepted and the milestone on the project altered accordingly.

A request is also pending from Assoc Prof Michael Geddes to extend the work on tail fan damage for a period of 6 months with additional funds.

Recommendation: This request will require review by the Steering Committee with subsequent ratification by the FRDC Board.

Dr Robert van Barneveld
RLEAS Leader
December, 2000

Rock Lobster Enhancement and Aquaculture Subprogram

Annual Operating Plan - 2002

Prepared by **Dr Robert van Barneveld**
Subprogram Leader

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A) ACTIVITY DESCRIPTION FOR 2000-2001

i) Sector Progress

Rock lobster enhancement and aquaculture is now a reality in Australia and has existed in New Zealand for some years. The following outlines some of the current activities by region:

Tasmania

Collection of puerulus from the wild and on-growing to a marketable size is now underway in Tasmania. This form of aquaculture and enhancement is based on high mortality of wild puerulus in their first year post settlement (anywhere from 75-97%) compared with animals brought ashore and ongrown in tanks where the mortality is minimal (2% in Tasmania). This gives rise to the theory aquaculturists can ongrow the 'excess' that would have died in the wild. This year in Tasmania, 7 licences were issued for the collection of 50,000 puerulus each. The licences are for an initial 12 month period, after which time they will be reviewed (in terms of successful application and commitment to use) by the Tasmanian Department of Primary Industries. The licences were issued at a cost of \$5,000 each and a condition of use is that approximately 25% of the total number of puerulus collected are re-seeded into the wild fishery as juveniles at 1 year. An officer will be appointed within the DPI to monitor both the collection and reseedling processes. The development of conditions associated with the issuing of licences was in full consultation with the existing wild capture sector. At present, collection of puerulus has commenced, with collection from salmon nets alone (all of which would have otherwise died during normal net cleaning processes) already yielding 2000 puerulus which have been provided to the Tasmanian Aquaculture and Fisheries Institute for re-seeding research.

There are a number of interesting points to note in relation to issuing of puerulus collection licences in Tasmania:

- There were at least 20 applicants for the 7 licenses on offer signalling significant interest in rock lobster aquaculture;
- Of the 7 licenses issued, none are currently held by commercial rock lobster fishermen.

South Australia

Aquaculture activities in South Australia continue to focus on on-growing and value adding to adult wild-caught lobsters. In the past, pontoons have been used to hold and feed lobsters prior to sale facilitating more control over the market the lobsters are sold into and the timing of the sale. There is the potential to achieve weight gains of around 20% by growing the animals through the annual moult, representing a 60% return on investment. Some difficulties have been encountered with the renewal of leases for sea cages in South Australia, and hence interest in this form of aquaculture is changing focus to land-based raceway systems. Current activities include investigations into the

holding and feeding of lobsters in land-based tanks using both existing flow through systems and infrastructure or recirculation systems.

Queensland

M G Kailis have forged an alliance with the Queensland Department of Primary Industries to investigate the potential of culturing and growing tropical rock lobsters. To date, research has focused on many aspects of production, but propagation of tropical lobsters remains the highest priority. Phyllosoma have been grown to Stage 9 over a period of 85 days, with each attempt improving survival rates.

New Zealand

Rock lobster aquaculture based on quota buy-out schemes in return for puerulus collection licenses (in the order of 1 tonne of quota in return for 40,000 puerulus) has been in place in New Zealand for some years. The success of these ventures has been variable.

Other developments

Interest continues to grow in other Australian states. Opportunities to develop rock lobster aquaculture enterprises in conjunction with existing aquaculture infrastructure is being investigated in both the Northern Territory and Western Australia. For example, management of pearl lines involves regular inspection and it is clear that puerulus are regularly brought to the surface with the lines. The frequency of appearance, the dominant species present and the potential to harvest and on-grow these puerulus requires further investigation, but is an existing consideration.

ii) Major research outputs of the Subprogram

A number of Subprogram projects have now been completed. A short summary of the outcomes from some of these projects and the status of final reports is presented below. Copies of final reports that have been accepted by FRDC can be obtained from the Subprogram Leader.

98/300: Propagation of rock lobster – development of a collaborative national project with international partners

Principal Investigator: Dr Piers Hart
(Tasmanian Aquaculture and Fisheries Institute, Marine Research Laboratories, Nubeena Crescent, Taroona, TAS, 7053)

Final Report Status: A final report in the form of workshop proceedings has been accepted by FRDC.

Outcomes: The outcome of the workshop was that, while many questions remain unanswered, sufficient information is currently available to suggest that rock lobster propagation is not only practically feasible, but there are strong indications that a rock lobster hatchery could be commercially viable. On this basis, it was agreed that a research and development plan should be pursued and a funding application submitted to FRDC for an initial 1 year research project with an expectation of a longer and more elaborate project to follow. These recommendations were obviously endorsed with these two projects subsequently being funded by FRDC.

98/301: Rock Lobster Enhancement and Aquaculture Subprogram: Facilitation, administration and promotion of the FRDC Rock Lobster Enhancement and Aquaculture Subprogram.

Principal Investigator: Dr Robert van Barneveld
(Barneveld Nutrition Pty Ltd, 19-27 Coonan Rd, South Maclean, QLD, 4280)

Final Report Status: A draft final report has been prepared for consideration by FRDC.

Outcomes: This project was successful in establishing a functional subprogram with inputs from a wide range of industry sectors. It convened a total of three workshops in Australia and New Zealand and forged the development of international research collaborations. By focusing research priorities, this project has ensured that the technology will exist for the development of Australian rock lobster enhancement and aquaculture systems.

98/303: Feed development for rock lobster aquaculture

Principal Investigator: Dr Kevin Williams
(CSIRO Division of Marine Research, Marine Laboratory, 233 Middle Street, Cleveland, Qld, 4163)

Final Report Status: Draft final report submitted for consideration by the Steering Committee and FRDC.

Outcomes: This project has addressed a range of issues associated with the nutrition of juvenile and adult lobsters including the successful development of manufactured feeds for captive lobsters.

98/304: Pilot study of disease conditions in all potential rock lobster aquaculture species at different growth stages

Principal Investigator: Assoc Prof Louis Evans
(Curtin University of Technology, Aquatic Sciences Research Unit, GPO Box U1987, Perth, WA, 6001)

Final Report Status: Pending

Outcomes: A lobster health network was successfully established as part of this project and an international symposium on lobster health management was convened in conjunction with the Third International Lobster Congress in South Australia.

98/305: Determination of optimum environmental and system requirements for juvenile and adult rock lobster holding and grow-out

Principal Investigator: Assoc Prof Mike Geddes
(University of Adelaide, Department of Zoology, GPO Box 498, Adelaide, SA, 5001)

Final Report Status: Draft final report submitted for consideration by the RLEAS Steering Committee and FRDC.

Outcomes: Outcomes from this project will allow aquaculturalists, rock lobster fishers and processors to make better informed decisions about holding systems, holding times, feeding regimes, feed types and selection of lobsters and long term live-holding of *Jasus edwardsii*. In addition, the project has defined temperature, salinity and density optima for the tank culture of *P. ornatus*, basic production protocols for *P. ornatus*, and the commercial aquaculture potential of *P. ornatus*.

99/314: Preliminary investigation towards ongrowing puerulus to enhance rock lobster stocks while providing animals for commercial culture

Principal Investigator: Dr Caleb Gardner
(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: Draft final report submitted for consideration by the RLEAS Steering Committee and FRDC.

Outcomes: Survival results from this project are encouraging for the future of reseeding aquaculture grown juveniles, however, caution is urged in their interpretation. There is evidence that survival varies greatly between habitats and/or regions, and seasonal effects are also likely. Most importantly, this study has shown that obtaining accurate estimates of short term survival of juvenile lobsters is

both possible and practical. There is confidence that results from the model, and new knowledge on juvenile lobster movement can be used to design a robust study to predict likely survival of reseeded lobsters across habitats, geographic regions and seasons.

99/315: The development of rock lobster propagation techniques for aquaculture in Australia

Principal Investigator: Dr Piers Hart

(Tasmanian Aquaculture and Fisheries Institute, Marine Research laboratories, Nubeena Crescent, Tarooma, TAS, 7053)

Final Report Status: Pending

Outcomes: The results from this project have begun the construction of a picture of phyllosoma development over time, which can be related to the structure of a potential culture technology. This information has been used to develop a further submission to FRDC for continued research into the propagation of lobsters with a focus on nutrition.

iii) Related projects and research linkages

The RLEAS currently maintains close research linkages with the following related projects:

1. MG Kailis/Queensland Department of Primary Industries research program into rock lobster aquaculture;
2. National Institute of Water and Atmospheric Research, NZ, research into rock lobster aquaculture and enhancement (independent of the research being conducted within the Subprogram).
3. Ferguson Fisheries research into the live-holding and feeding of Southern Rock Lobsters in recirculation systems.
4. All projects being managed by the Rock Lobster Post-Harvest Subprogram.

iv) Role RLEAS has played in industry development

Via the Subprogram Leader and the Steering Committee, the RLEAS has attempted to have an active role in all industry developments to date, either through providing research outcomes to support industry development, or by providing direct assistance with the procurement of funds or strategies to assist industry development.

v) Operating procedures

This Subprogram is highly responsive to the views of industry and understands the need to accommodate both the research requirements of the future and the needs of the existing wild fisheries and aquaculture industries. To ensure that research conducted within the Subprogram is relevant and meets the above criteria, a Steering Committee has been established to:

- Provide industry feedback and views;
- Review existing research based on FRDC contractual obligations;
- Prioritise new proposals and provide a priority list for other agencies;
- Ensure outcomes are commercially focussed;
- Coordinate industry and research provider involvement - optimum use of resources;
- Facilitate extension and technology transfer.

Membership of the Steering Committee includes Robert van Barneveld (Chair), Patrick Hone (FRDC), Pheroze Jungalwalla (TAS), Neil Stump (TAS), Lionel Carrison (SA), Greg Ward (SA), Barry Spurrier (VIC), David Lucas (VIC), Jim Fogarty (QLD), Ian Finlay (WA), John Newby (WA), Neil Dorrington (WA), Trevor Burkhart (NZ), Piers Hart (Scientific Adviser), Wayne Hosking (Scientific Adviser) and Bruce Phillips (FRDC Rock Lobster Post-Harvest Subprogram Leader).

The Steering Committee meets in March and September each year to review project progress and establish research priorities. Advice from the September Steering Committee is sent to all Fisheries Research Advisory Bodies so that they are aware of the subprogram research priorities. All new projects relating to rock lobster enhancement and aquaculture are assessed by the Steering Committee and are submitted to the FRDC Board via the Subprogram.

Industry consultation and communication: The Subprogram Leader, Dr van Barneveld, promotes the activities of the RLEAS through a website, industry newsletters, and direct communication with industry organisations and representatives.

Strategic planning: Strategic planning for the RLEAS will be based on outcomes from the existing research program and ongoing consultation between the Subprogram Leader and members of industry and researchers in Australia and New Zealand. The strategic plan will be maintained and updated annually using CD-ROM for distribution. The strategic planning process will identify those factors that represent restrictions to the initial establishment of rock lobster aquaculture (eg. propagation, nutrition) and enhancement (eg. monitoring survival, prevention of disease introduction to the wild fishery) processes, and then will utilise a relative ranking score from the various rock lobster fisheries across Australia.

Communication with FRABS: Communication with FRAB's is via distribution of an annual operating plan for the RLEAS in December of each year combined with direct communications. The Subprogram Leader will also attend the annual FRDC FRAB workshop to promote the activities and objectives of the RLEAS.

Development of new research proposals: New research proposals are developed through the use of facilitated strategic planning meetings. Using priorities published in the RLEAS Strategic Plan, the Subprogram Leader convenes meetings with relevant researchers and research institutions to:

1. Define the planned outcomes of the new proposal;
2. Manage an indicative budget for the research as defined by the Steering Committee;
3. Identify which researchers/institutions are best placed to undertake the research;
4. Promote collaboration between researchers and institutions where appropriate;
5. Seek external expertise and inputs as required.
6. Ensure the new proposal meets the objectives of the subprogram and that the research remains relevant and focussed.

The Subprogram Leader ensures new research proposals are distributed to FRABS and the RLEAS Steering Committee for comment and ratification before submitting the proposals to FRDC on behalf of the lead agencies, or facilitating adjustments to the proposals prior to submission.

Coordination of research reports: The Subprogram Leader collates progress and final reports from projects within the Subprogram in March and September each year for delivery in a common format to FRDC. These reports are distributed to members of the Steering Committee for comment and review.

Review of research progress and direction: The RLEAS Steering Committee interviews the Principal Investigator of each project within the Subprogram at least once annually as part of the Steering Committee meeting. Principal Investigators are expected to report progress against contracted milestones, justify any changes in research direction, and demonstrate that the research program is making a valuable contribution towards the achievement of the Subprogram objectives. The Steering Committee makes recommendations to the FRDC Board in relation to potential changes to the objectives of the research program, or instances where project progress is unsatisfactory.

Coordination of research extension: A major function of the Subprogram Leader is the organisation and delivery of an annual research workshop to highlight the activities and outputs of the RLEAS. Workshops are convened with presentations from invited speakers and researchers aimed at

delivering key messages to end-users for use in practical rock lobster aquaculture and enhancement systems.

The Subprogram Leader compiles a subprogram newsletter "Lob ReLEASE" at least annually or as required highlighting research outcomes, developments in rock lobster enhancement and aquaculture and events relevant to the RLEAS. The Subprogram Leader is also responsible for the approval of all media releases and scientific publications arising from research projects within the Subprogram using the RLEAS Steering Committee communication policy as a guide.

Collaboration with international partners: The Subprogram Leader has established a major international collaboration between researchers in Australia and New Zealand through project 98/301. This was achieved through direct interaction with researchers in New Zealand and involvement of these scientists in the RLEAS research program. There is further opportunity to build on relationships initiated with Japanese researchers by AIMS, CSIRO and TAFI as the RLEAS continues to evolve. In all cases, international collaborations will be based on a two-way flow of information and where possible, research funds.

Identification and procurement of additional funding: Additional funding from sources such as the Public Good Science Fund in New Zealand and AUSIndustry in Australia will be procured with the assistance of the Subprogram Leader and relevant end-users. The Subprogram Leader is already involved with the development of AUSIndustry COMET proposals for the commercialisation of existing technology for rock lobster aquaculture. There are also opportunities for commercial investment in the development of technologies for rock lobster aquaculture in conjunction with the existing research program.

Liaison with FRDC: The Subprogram Leader is the conduit for communications between FRDC and subprogram participants in relation to project contracts, project reports, new submissions and general correspondence. The Subprogram Leader also represents the RLEAS at the annual FRDC FRAB and Subprogram meetings in Canberra.

vi) Meetings and Workshops

The next RLEAS workshop will be held in Cairns on May 29, 2002 in conjunction with the Rock Lobster Post-Harvest Subprogram. The workshop will highlight developments in aquaculture and enhancement and will provide an opportunity for the inspection of the new QDPI aquaculture research facilities. Further details will be made available by the Subprogram Leader.

vii) Summary of current project status

Two new projects were approved by the FRDC Board to commence in July, 2001. The first of these projects (2001/211) maintains the management of the RLEAS for a further 3 years. The second (2001/094) is the first stage in a health assurance program that is closely linked with industry developments in Tasmania where there is a requirement for a proportion of aquaculture-reared wild-caught puerulus to be released back to the wild as year-old juveniles.

A summary of the current core projects within the Subprogram and their duration is presented below:

Project	Year			
	00/01	01/02	02/03	03/04
98/302 – Towards establishing techniques for large scale harvesting of pueruli and obtaining a better understanding of mortality rates.				
2000/185 – Evaluating the release and survival of juvenile rock lobsters released for enhancement purposes.				
2000/211 – Investigation into tail-rot necrosis in live-held adult lobsters.				
2000/212 – The nutrition of juvenile and adult lobsters to optimise survival, growth and condition.				
2000/214 – Advancing the hatchery propagation of rock lobsters				
2000/263 – Reducing rock lobster larval rearing time through hormonal manipulation.				
2001/211 – Strategic planning, project development, and facilitation of research and extension towards establishment and maintenance of commercial rock lobster aquaculture and enhancement systems in Australia.				
2001/094 – Health assurance for southern rock lobsters				

B) SUMMARY OF STRATEGIC PLAN

The Rock Lobster Enhancement and Aquaculture Subprogram (RLEAS) was established in July, 1998 with the following objective or “mission”:

“To provide technology for use in Australian rock lobster enhancement and aquaculture systems so they can be internationally competitive and can operate in harmony with the wild fisheries”.

It is important to note that the role of the RLEAS is not necessarily to promote aquaculture development, but to ensure the existing rock lobster industries have the capacity to pursue enhancement and aquaculture of rock lobsters if the net benefits clearly exceed any negative aspects. The Subprogram also ensures that the research and development program gives due consideration for the following:

- Protection of the wild fishery in terms of economic and social viability;
- Neutral or positive impact on the wild fishery in terms of stock numbers;
- Commercial viability of closing the life cycle of rock lobsters;
- Increasing profitability and wealth for Australasia;

The key research areas within the Subprogram are presented below:

- Species selection for aquaculture;
- Puerulus collection from the wild;
- Biological neutrality of wild stocks;
- Larval rearing/propagation of all species of rock lobsters;
- Nutrition of juveniles and adult lobsters;
- On-growing of juveniles and system requirements;
- Health of aquaculture reared juveniles;
- Economics and marketing;
- Enhancement of wild stocks through reseeded or resettlement.

At its last meeting in September, the RLEAS Steering Committee re-addressed the following questions in an attempt to update the existing strategic directions:

1. Where is the RLEAS going?
2. What is the RLEAS looking for?
3. Is the RLEAS over committed?
4. Is the RLEAS meeting its objectives?

The outcomes from discussions based on these questions were as follows:

- The Steering Committee deemed the propagation question as still being critical and deemed that more outcomes from this research were required before additional strategic decisions could be made.
- A key target for the RLEAS was to derive technologies that allowed enhancement of rock lobster populations through aquaculture, and the maintenance of a rock lobster population in an aquaculture system.
- The Steering Committee decided to use and maintain the original RLEAS research priority list until more outcomes from propagation research were realized and a revised research direction could be formulated.
- For information, the initial priority matrix established by the Steering Committee in relation to the allocation of funds was:

▪ Broodstock	19%
▪ Culture	30%
▪ Wild Collection	14%
▪ Ongrowing	16%
▪ Enhancement	11%
▪ Economics/Marketing	13%
- The Steering Committee were able to further define some aspects of the RLEAS research priority list. Having completed research into puerulus collection and biological neutrality, it was made clear that enhancement of existing habitats to improve puerulus survival was still unresolved. It was also decided that the economics and marketing priority should be divided into two sections. Issues dealing with the costs of undertaking aquaculture activities and issues dealing with the impact of aquaculture products on existing markets, and markets for aquaculture products themselves. It was felt that those planning to undertake aquaculture activities are in the best position to define the costs and hence this should not form part of the RLEAS funding priorities. In addition, different states have different policies and directions as to where they want to go with aquaculture, and hence it is difficult to conduct research into this aspect that will be relevant for all areas.
- The Steering Committee identified a number of additional areas that needed to be addressed by the RLEAS, including:
 1. Concern re the perception of aquaculture product vs wild product;
 2. Continued resistance from the wild fishery;
 3. Highlighting the fact that collecting puerulus will never be a serious industry;
 4. Puerulus are seen in Taiwan as an aquaculture product

C) Communication and technology transfer

The Steering Committee has defined a policy for the distribution of information arising from research conducted within the Subprogram. The following guidelines will be applied when publishing research:

- Distribution of information must have a net benefit for the Australian industry.
- Dissemination of information to international partners will be approved when there is a two way flow of information.
- *Ad hoc* requests for results or information will not be accepted.

- Special cases for the supply of information will have to be approved by the Steering Committee and where appropriate, Memorandums of Understanding will be prepared.

The Subprogram publishes an annual newsletter called "Lob ReLEASE". The newsletter is the principal industry communication of the subprogram and has received good feedback from all sectors of the rock lobster industry.

A number publications are available or are pending from the Subprogram including:

- Proceedings of a lobster health workshop held in Perth in July, 1998.
- Proceedings of the Rock Lobster Propagation workshop held in Hobart in January, 1999.
- Proceedings of the first annual RLEAS workshop held in Geraldton in March, 1999.
- Proceedings of the second annual RLEAS workshop held in Hobart in February, 2000.
- Proceedings of the third annual RLEAS workshop held in New Zealand in April, 2001.
- Final reports from completed projects.
- "Lob ReLEASE" Volume 1, Issues 1, 2 and 3.
- Scientific publications from completed and existing research projects.

D) PROPOSED NEW RESEARCH

Based on the current project base, and the outstanding priorities, the RLEAS was only seeking projects relating to the economic issues associated with the entry of aquaculture product into traditional markets. Despite this, a total of seven preliminary research proposals were submitted. The RLEAS Steering Committee offered the following comments on these proposals:

1. Studies of diseases and disease syndromes of cultured and captive lobsters – Ben Diggles, NZ.

Priority: Low. Turgid lobster syndrome was not seen as a major industry problem. Many aspects of the proposal were more relevant to the Rock Lobster Post-Harvest Subprogram and accordingly, the PRP was forwarded to this Subprogram for comment. The RLEAS did not support progression of this application to a full proposal.

1. Economic assessment of the potential for aquaculture of the Western rock lobster – Tim Martella
2. Pilot scale production of Western rock lobster in onshore flow through tanks – Justin Bellanger
3. Economic feasibility of the enhancement or culture of Western rock lobsters – Richard Stevens

Priority: Low: These PRP's were considered simultaneously given their similar nature. Based on the discussions outlined under the summary of the strategic plan, the Steering Committee felt that these research areas were either already being covered within the RLEAS, or that this type of information was best collected by those planning to establish rock lobster aquaculture facilities. The RLEAS did not support progression to a full proposal.

5. Enhancement of the survival of juvenile Western rock lobsters – Bruce Phillips

Priority: High: This project seeks to further explore habitat enhancement to increase survival of WA rock lobster puerulus. This has always been recognised as a key research priority for the WA industry and the project was strongly supported by the Steering Committee. Progression to full proposal was endorsed while it was recognised that there is a need to address the environmental concerns regarding artificial environment modifications.

6. Impacts of aquaculture lobster in major Australian markets and industry – Roger Edwards

Priority: Medium: This topic is important to the wider subprogram but the Steering Committee are uncertain whether too many assumptions would have to be made during the conduct of the work. It

was recommended that a number of case studies be prepared based on other aquaculture industries for presentation at the Subprogram workshop planned for Cairns in May, 2002 before further work be undertaken. The RLEAS supported development of a modified proposal for consideration by FRDC.

7. Developing tropical rock lobster aquaculture in conjunction with existing aquaculture farms in Northern Territory – Ram Mohan

Priority: Medium: While this proposal was innovative, it was thought to conflict with a number of commercial pursuits. The Steering Committee supported preparation of a modified full proposal that addressed the surveying component of the research.

E) WORKPLAN FOR THE NEXT 12 MONTHS

Workplans have been developed for the first 12 months of each project. As most of these projects are very large in nature with a number of collaborators, it is not possible to include detail in this document. If further information is required on the workplans for each project, the Subprogram Leader can provide this information from the Steering Committee minutes.

F) BUDGET

Existing RLEAS projects and budgets are as follows:

		00/02	02/03	03/04
2000/185	Enhancement	\$139,000		
2000/211	Disease	\$20,000		
2000/212	Nutrition	\$66,000	\$65,000	
2000/214	Propagation/Hatching	\$208,000	\$172,239	
2000/263	Propagation/Hatching	\$60,000	\$62,000	
2001/211	Co-ordination	\$100,000	\$100,000	\$100,000
2001/094	Health	\$67,000	\$10,100	
		\$661,000	\$409,000	\$100,000

- RLEAS has allocated rock lobster propagation as our highest priority and currently work on an indicative research budget of \$0.5 million per year. We have done well in defining our budget and research program in the past but now need to adjust it for the future. RLEAS has existing commitments of \$415,000 and is in the process of defining a vision beyond 2002.

G) Variations

Nil.

Dr Robert van Barneveld
RLEAS Leader
December, 2001