NATIONAL ROCK LOBSTER MANAGEMENT GROUP

NRLMG 2010 ANNUAL REPORT

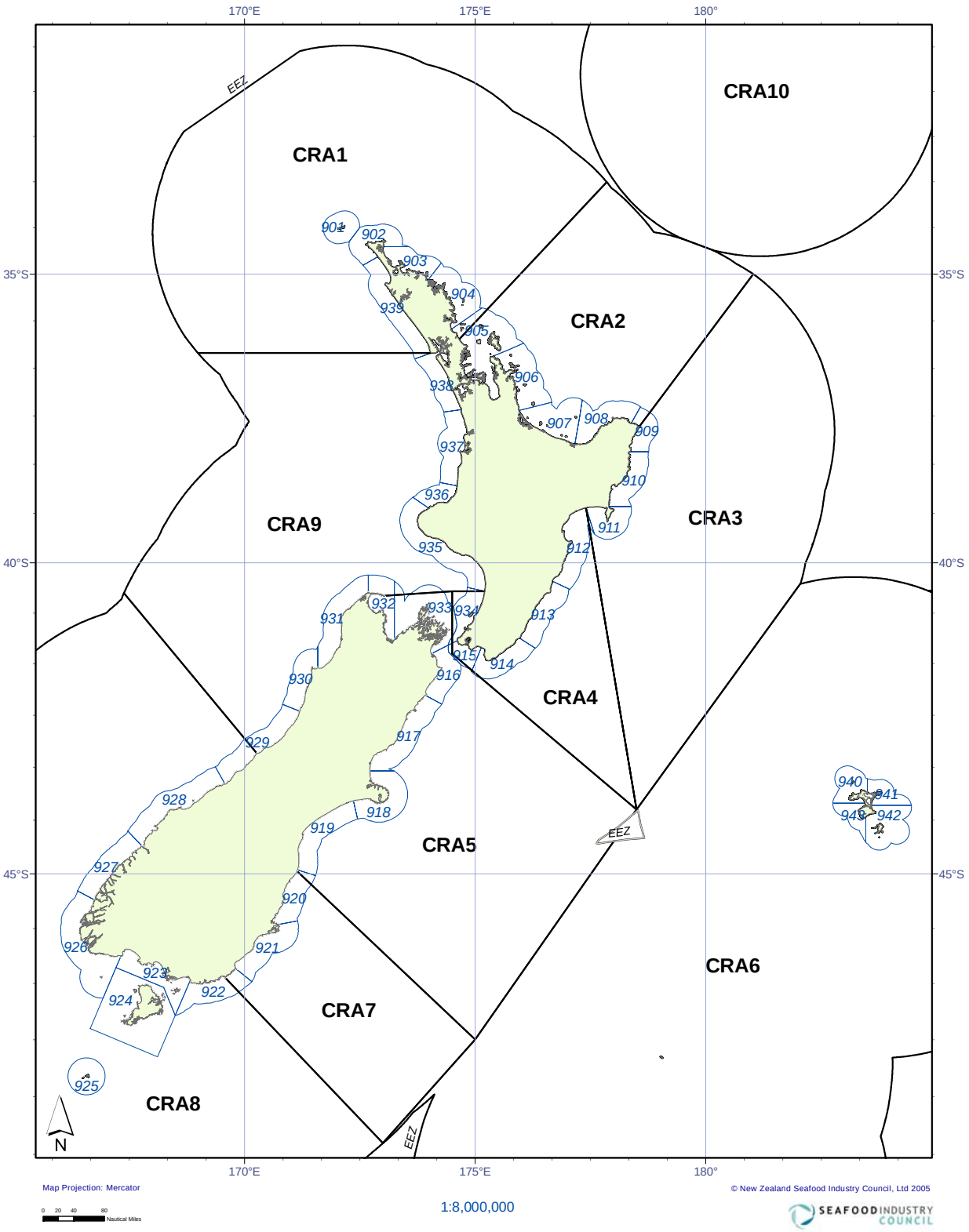
To

The Minister of Fisheries

HON. PHIL HEATLEY

NEW ZEALAND ROCK LOBSTER FISHERY MANAGEMENT AREAS

New Zealand CRA Quota Management and Statistical Areas



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1. SUMMARY OF THE NRLMG REPORT

1. This report from the National Rock Lobster Management Group (NRLMG) is primarily an information document and a comprehensive background to NRLMG advice and recommendations to the Minister of Fisheries on sustainability measures and management controls for rock lobster fisheries. The NRLMG would like to bring your attention, in particular, to:

   a) the operation of Management Procedures for CRA 4, CRA 5, CRA 7 and CRA 8 and the NRLMG initial advice on management interventions for the 2011/12 fishing year beginning April 2010 (Annex 3);

   b) the priority issues relating to uncertainty in estimates of total removals and compliance and enforcement identified by the NRLMG; and

   c) the ongoing review of the NRLMG, including its role, function, strategic vision, and framework for managing fisheries;

2. The NRLMG recommends that you:

   a) **reconfirm** your endorsement of the role and function of the NRLMG;

   b) **direct** MFish to coordinate release of the NRLMG initial advice on management interventions for public consultation; and

   c) **note** that the NRLMG will provide you with final advice on management interventions in February 2011.

2. PURPOSE OF THE NRLMG ANNUAL REPORT

3. The purpose of the NRLMG Annual Report is to provide information on rock lobster fisheries and a comprehensive background to NRLMG advice and recommendations on sustainability measures and management controls for rock lobster fisheries to the Minister of Fisheries.

4. The Report reviews a range of topics considered and activities undertaken by the NRLMG during 2010. The report includes:

   a) NRLMG initial advice on management interventions for rock lobster fisheries for the 2010-11 fishing year;

   b) a description of the role and function of the NRLMG;

   c) a description of the framework for managing rock lobster fisheries;

   d) an explanation of stock assessments and management procedures;

   e) an outline of priority management issues; and

   f) a description of New Zealand rock lobster fisheries.

5. The NRLMG initial advice on rock lobster fisheries fulfils the role of a Ministry of Fisheries (MFish) Initial Position Paper (IPP) and is the basis for the Minister's statutory consultation with stakeholders on rock lobster issues. The NRLMG initial advice is set out in this report but a separate Public Consultation Document has also been produced to facilitate the consultation process (Annex 3).

6. This year, the NRLMG is proposing adoption of management procedures to guide statutory TAC setting in the CRA 5 and CRA 7 fisheries and variations to the TACs and allowances set for the CRA 4, CRA 5, and CRA 8 rock lobster fisheries. Changes to Deemed Values for rock lobster stocks are also proposed.

3. ROLE AND FUNCTION OF THE NRLMG

7. The NRLMG is the primary source of advice to the Minister of Fisheries on rock lobster fisheries issues. The NRLMG comprises representatives of the customary Maori, amateur, commercial, environment and conservation interests, and delegated MFish personnel, NIWA, SeaFIC, and other consultant science advisors also assist the NRLMG.

8. In 1992, the then Minister of Fisheries, Hon D L Kidd, endorsed the establishment of a national group, the NRLMG, to revise and develop the Rock Lobster Management Plan devised by the Rock Lobster Steering Committee (RLSC) (1991) and asked sector groups to nominate representatives. The RLSC was established by the same Minister to develop a long-term management plan for the lobster fisheries that at that time were considered to be seriously depleted by overfishing.

9. The NRLMG has since presented seventeen annual reports, containing recommendations for the sustainable management of these most important New Zealand inshore fisheries. The NRLMG seeks technical advice from experts, and develops refinements and improvements to the management regimes currently in place for rock lobster fisheries.

10. The NRLMG strives to provide quality advice to the Minister to assist in the statutory decisions on TACs, TACCs, and other management controls.

Role of the NRLMG

11. The NRLMG operates in accordance with standards and specifications drawn from an extensive review in 2001 of the role and objectives of the NRLMG in consultation with the Minister of Fisheries. The NRLMG and the Minister agreed:

a) to maintain the NRLMG as the primary source of advice to the Minister of Fisheries;

b) to encourage and coordinate the development and implementation of Fishery Plans for rock lobster fisheries;

c) to act as a default regional planner for rock lobster research and management in circumstances where no Fishery Plan proposal was contemplated, or where a lack of organisation and coordination precludes any regional oversight by sector groups;

d) to retain a national coordinating body with well established and identifiable links to and from regional sector groups;

e) to coordinate and provide sector group input to research and information planning processes;

f) to coordinate and provide input to, and maintain an oversight of, the relevant Working Group processes and timetables;

g) to provide well informed, credible, and consistent research and management information and advice to sector groups, Government agencies, and Ministers.

Roles and responsibilities of members and advisers

12. Noting a preference for membership and participant numbers being kept at current levels with some flexibility accorded to need and circumstance, the NRLMG and the Minister also agreed the roles and responsibilities of the participating members and advisers as follows.

13. Sector Representatives – TOKM, NZRFC, NZ RLIC, ECO.

a) To provide consistent expertise, experience, knowledge, networking – to and from sector constituency. "*It is important that each member represents the views of their constituent groups and relays discussions from the Group back to their constituents*"… (Hon. Pete Hodgson, March 2001)

14. MFish – Fisheries Management, Compliance Advice, Science

a) To facilitate and coordinate information and advice to and from the NRLMG;

b) To ensure consistent information and advice to MFish personnel and to tangata whenua;

c) To enable science (including stock assessment and biological), economic, social policy, and other advice deemed necessary by the NRLMG.

15. Advisory members – Stock Assessment, Biology and Behaviour, Economic, Social

a) To maintain oversight of NRLMG deliberations and offer advice and guidance, including cautions, to assist the development and implementation of research and information plans, Fishery Plans, or regional harvest initiatives.

16. Chairman

a) To facilitate NRLMG meetings and to oversee the development and delivery of the NRLMG Annual Report.

17. The NRLMG has not only played a role in developing a significant level of consensus among user groups, which aids the decision making process, but also has encouraged the

development of management initiatives throughout the country which have contributed to the improvement in rock lobster stocks over recent years.

18. Stock assessments since 1992 have tracked increasing abundance in most fisheries, and where stock rebuild has been less than optimum, management responses have been implemented which should ensure the sustainable utilisation of those fisheries within acceptable stock rebuild timeframes.

19. The NRLMG advises and informs regional stakeholder groups. This ensures that local issues are addressed within the context of the Fisheries Act and in a manner that is consistent with the overall harvest strategy for rock lobster fisheries.

20. The NRLMG continues to persevere with its efforts to formulate robust and enduring harvest strategies that will not require annual review, rather only fine-tuning when new information indicates that some adjustment is necessary. To that end, the NRLMG continues to develop and refine management procedures incorporating 'harvest control rules' which are designed to guide management actions.

2010 Work Programme

21. The NRLMG has given consideration to a number of rock lobster fisheries management issues during 2010. The most important of these are:

a) contributing to an MFish review of the role and function of the NRLMG which is yet to be completed but which will be reported to the Minister of Fisheries in 2011. The review has not impeded the work of the NRLMG during 2010.

b) research programme activities, including oversight of the development and operation of a stock assessment and Management Procedure for CRA 5; a revised Management Procedure for CRA 7; and the operation of Management Procedures for CRA 3, CRA 4, CRA 5, CRA 7 and CRA 8;

22. Also in 2010 a primary function of the NRLMG was to conduct Rock Lobster Research Planning, and in that role to evaluate the full range of medium term research activities considered relevant to the agreed plan and strategic vision for rock lobster fisheries. The NRLMG again provided the core sector group participation in the annual Rock Lobster Research Planning Group process which culminates in MFish recommendations to the Minister of Fisheries in relation to required research services.

23. In addition, some members of the NRLMG have attended and participated in the Rock Lobster Fisheries Assessment Working Group (RLFAWG) meetings held during 2010. The NRLMG contributed to the development of management procedures and agreed biological reference points for incorporation into fisheries management decisions.

24. Over the past year the NRLMG convened on eight occasions to deliberate on a range of research, planning and management issues with the aim of confirming advice and recommendations for regulatory amendments to meet statutory timetables and to ensure the presentation of this annual report and sustainability recommendations to the Minister of Fisheries by 10th December 2010.

Organisational Arrangements

25. Costs of participation in the NRLMG are borne by the representative organisations, and the NZ RLIC usually supplies venues and facilities. The NZ RLIC and MFish share secretarial and administrative duties. MFish now funds the travel costs associated with recreational sector representation to the NRLMG.

ATTENDANCE DURING 2010

Representation	Meetings Attended	Apologies
Chairman / Acting Chairman	8	-
Ministry of Fisheries	8	-
NZ Recreational Fishing Council	8	-
Te Ohu Kaimoana	8	-
Environment and Conservation Organisations	0	-
NZ Rock Lobster Industry Council	8	-
Science Advisors	5[1]	-

IN SUMMARY

26. The NRLMG notes:

a) that whilst supporting and encouraging the development and implementation of Fishery Plans for rock lobster, the NRLMG will continue to operate the current management framework outlined in this document and will work within the roles and responsibilities confirmed in the most recent review;

b) the NRLMG is supporting and encouraging the development and implementation of Fishery Plans for rock lobster;

c) that previous Ministers have endorsed the NRLMG as the primary source of TAC, TACC and management advice for New Zealand rock lobster fisheries; and

d) that previous Ministers have endorsed the NRLMG as an appropriate body to consult on any matters relevant to the management of rock lobster fisheries.

27. The NRLMG recommends that you:

a) **reconfirm** your endorsement of the role and function of the NRLMG.

[1] Science Advisors attend as required

NRLMG membership in 2010

Steve Halley	Chairman	MFish
Dr Kevin Sullivan	MFish	
Alicia McKinnon	MFish	
Alan Riwaka	Te Ohu Kaimoana Trustees Ltd	
Stan Pardoe	Te Ohu Kaimoana Trustees Ltd	
Keith Ingram	NZ Recreational Fishing Council	
Geoff Rowling	NZ Recreational Fishing Council	
Malcolm Lawson	NZ Rock Lobster Industry Council	
Daryl Sykes	NZ Rock Lobster Industry Council	
No nominee	Environment & Conservation Organisations	

Science Advisers to the Group

a) The NRLMG draws on a range of sources of science advice including but not restricted to the membership of the Rock Lobster Fishery Assessment Working Group convened by MFish.

4. STRATEGIC VISION

28. The NRLMG has developed a Strategic Vision for the NZ Rock Lobster Fisheries. The vision is consistent with the Fisheries Act 1996, enhances an agreed management framework, and provides a basis for consideration of short, medium, and long term research and management issues, including that:

a) rock lobster stocks will be managed effectively (including cost effectively) to maintain the status of the stocks at or above the agreed biological reference points, consistent with the Minister's legislative responsibility;

b) fisheries will be managed using a property rights/ Quota Management System (QMS) regime with the principal management actions exerted via output controls (TACs) while a range of input controls will still apply where this proves appropriate to individual situations;

c) the strategy will provide for management flexibility, whilst ensuring sustainability, to enable all sector groups to maximise their benefits within a shared fishery;

d) management of the fisheries will take place within a clear policy environment, e.g., there will be clear, explicit, and agreed rules to describe property rights in the fisheries and the allocation between user group sectors. In addition, there will be explicit and agreed decision rules to prescribe management actions that result from monitoring and assessment of fisheries;

e) reliable and cost effective means to monitor and assess fish stocks will be in place. The catches taken and effort deployed by all extractive user groups will be effectively quantified, documented, and managed in accordance with the exercise of rights;

f) adverse environmental effects of fishing activities will be averted or minimised;

g) aquaculture of rock lobsters will be a permissible activity, governed by policies which ensure sustainable use of the wild stock within a rights based framework;

h) a shift of management responsibility to user groups will be promoted within the Fishery Plan framework provided for in the 1996 Fisheries Act;

i) collaborative/consultative national co-ordination of research and management recommendations and development of policy will continue within the NRLMG or similar organisation;

j) co-operative management initiatives, which may include the development of regional user groups and Fishery Plans, will be encouraged; and

k) sustainable management and use of rock lobster fisheries will occur in an environment where the New Zealand public are well informed and educated on matters dealing with fisheries in general and rock lobster fisheries in particular.

5. FRAMEWORK FOR MANAGING ROCK LOBSTER FISHERIES

29. The framework for managing rock lobster and the attendant recommendations of the Group are consistent with expectations of a robust and enduring harvest strategy leading to a continuing sustainability of rock lobster stocks, and in the view of the Group are also consistent with the statutory obligations enshrined in the Fisheries Act 1996.

Goal

30. The rock lobster fisheries should be managed and be maintained at or above the assessed and agreed biological reference points, using a comprehensive approach that recognises a range of commercial, customary non-commercial, amateur, and environmental concerns and values.

Strategies to Achieve Goal

31. The strategies will allow the population size to:

a) increase in each fishing year that it is below the target in agreed management procedures; or be maintained at or above that level.

32. The extent of change in population size that can be sought will be determined after consideration of:

a) economic and social factors including:

(i) the economic cost and benefits, social factors and rate of adjustment to the fishing industry,

(ii) the availability of rock lobster to Maori and amateur fishing groups,

(iii) the economic return from the fishery; and

b) biological and environmental factors including:

(i) the uncertainty in the assessment of stock size and other biological parameters, and

(ii) the risk to the population; and

c) the timeframe over which the management options will have effect.

33. The strategies will identify the effects of fishing on the aquatic environment and provide for the implementation of measures to:

a) avoid, remedy, or mitigate any adverse effects of fishing on the aquatic environment;

b) maintain associated or dependent species above a level that ensures their long-term viability;

c) maintain the biological diversity of the aquatic environment; and

d) protect habitat of particular significance for fisheries management.

Implementing the Strategies

34. The tactics or actions developed to implement the strategies will:

a) be produced through a process that involves all sector groups, minimises conflicting views, and involves all participants in the group disclosing their positions on the issues considered in order to promote co-operation and encourage full and frank discussion;

b) be based on advice from scientists on the steps necessary to achieve the goal within various time frames;

c) consider available management options including but not limited to catch reductions, area closures, gear restrictions, enhancement, legal size changes, measures to maximise egg production, recruitment, and to minimise juvenile mortality;

d) promote and enable effective, including cost effective, compliance with fishery rules;

e) consider the costs and implications of management options including:

i. the resources that are needed and currently available for research, compliance and administration;

ii. the integrity of the research database;

iii. whether the management alternatives can be effectively implemented;

iv. how the impact of the management options are to be measured or estimated;

v. the impact of the management options on industry, customary non-commercial, and amateur fishers and the degree of their acceptance of the measures; and

vi. the impact on other fisheries and the aquatic environment.

f) be based on the best available information;

g) recognise any uncertainty in the available information and be precautionary when information is uncertain, unreliable, or inadequate; and

h) not use the absence of, or any uncertainty in, any information as a reason for postponing or failing to take any measure to achieve the purpose of the Fisheries Act 1996.

35. The NRLMG will provide a timely annual report containing recommendations for management, research and compliance of rock lobster fisheries to the Minister.

HARVEST STRATEGY

36. The NRLMG pursues a dynamic harvest strategy for rock lobster fisheries. It is willing to consider and accept TAC changes in two situations:

a) where stock modelling demonstrates that, after a TAC change, abundance is likely to move towards agreed biological reference points within an agreed period; and

b) where a TAC change is triggered by a fully tested and accepted management procedure (including a harvest control rule), such as the ones described elsewhere in this report, designed either to rebuild a stock unit or to maintain the stock unit near an agreed biological reference point.

Assessment and Indicators

37. In accordance with the goal for managing rock lobster fisheries, stock assessment research will continue to be an important component of the management framework. The Rock Lobster Fisheries Assessment Working Group (RLFAWG) continues to refine and improve stock assessment techniques and to identify areas of uncertainty and information needs.

38. For a number of years, MFish has commissioned a major rock lobster stock assessment project incorporating extensive stock monitoring, data grooming and stock modelling, and a rock lobster recruitment project, based on monitoring puerulus settlement at selected sites around the New Zealand coast.

39. Since 1997 NZ RLIC has been contracted to provide stock monitoring and assessments in collaboration Breen Consulting, Haist Consultancy, NIWA, StarrFish, Trophia Research, and, for the first two periods, the SeaFIC Science Group. Within the overall research programme, the NZ RLIC has contracted NIWA, Lat37 Ltd, and Trophia Research and others to undertake catch sampling and data entry, and to construct and maintain databases for the tagging projects. NIWA holds the MFish contract for the rock lobster puerulus settlement project.

40. Intensive catch sampling (including logbooks) and tagging are undertaken to MFish agreed standards and specifications. Vessel logbook data are now routinely incorporated into the stock assessment process. Contracted Logbook programmes supervised by technicians are well established in CRA 2, CRA 5, and CRA 8 and voluntary programmes are operational in CRA 4, CRA 6 and CRA 9.

41. Breen Consulting, StarrFish, Haist Consultancy and Trophia scientists continue to refine and improve stock assessment methods with routine oversight from the RLFAWG chaired by MFish Science Group. The SeaFIC Science Group provides a useful peer review of the process.

42. An independent peer review of rock lobster stock assessment methodology commissioned by MFish in 2007 again concluded that key aspects of the current assessment model represent state-of-the-art methodology and are appropriate for assessments of the rock lobster stocks.

Rock Lobster tag and release with electronic data recording system

Management Procedures and Decision Rules

43. The NRLMG has established two simple decision rules for the NSN and NSC substocks. Each year, the rule for each substock compares the current estimate of standardised CPUE with the index from 1992-93. The two estimates are considered significantly different if their 1-standard-error bars do not overlap. Under these rules, stock assessments are triggered when the two CPUE estimates differ significantly.

44. A CRA 3 Management Procedure was developed for use during 2009 and from the two rule options recommended by the NRLMG; in March 2010 the Minister endorsed Rule 2(a) as being the suitable basis to guide his TAC decisions for that stock from 2010.

45. In 2005 CRA 4 commercial stakeholders collaborated with the stock assessment science team to develop and implement a Management Procedure benchmarked against reference levels used in the 2005 stock assessment. The procedure has been used in two successive seasons to guide industry decisions to voluntarily reduce the commercial catch limit in order to halt

an observed decline in CRA 4 stock abundance and improve the economic performance of the industry.

46. The CRA 4 Management Procedure has since been accepted by the NRLMG as a suitable basis on which to recommend to the Minister that TAC/TACC decisions be made for CRA 4.

47. In 2008 CRA 5 commercial stakeholders collaborated with the stock assessment science team to develop and implement a Management Procedure benchmarked against reference levels used in the 2004 stock assessment. The procedure is intended to maintain high levels of stock abundance and has not been invoked. A new CRA 5 Management Procedure was developed in 2010 on the back of a full stock assessment. That procedure is accepted by the NRLMG as the basis on which to recommend to the Minister that TAC/TACC decisions be made for CRA 5.

48. For the NSS substock (CRA 7 and CRA 8) the NRLMG recommended, and in 1997 the Minister accepted, a management procedure designed to rebuild these two stocks to their target levels. Later the NRLMG recommended, and in 2002 the Minister accepted, a more complex and extensively tested management procedure.

49. New management procedures designed to maintain the stock above sustainability reference levels were tested under the stock assessment research contract (CRA2003-02) in 2007. These were designed around a decision rule matrix that enables stakeholders to consider biological, economic and other outcomes, and their associated risks, when choosing fishery goals. The rules are described as "maintenance rules" and were agreed by the Minister in 2008 and are now routinely used to guide TAC/TACC decisions for both CRA 7 and CRA 8.

50. A revised CRA 7 Management Procedure has been accepted by the NRLMG as a suitable basis on which to recommend to the Minister in 2010 that TAC/TACC decisions be made for CRA7.

Tactics

51. There are a number of mechanisms by which total removals from the fishery can be adjusted if circumstances dictate. These are:

a) adjusting the TAC;

b) changes in minimum legal size (MLS) limits;

c) adjustments to escapement provisions;

d) closed seasons;

e) fishing method restrictions;

f) effort controls;

g) closed areas;

h) adjustments to commercial quotas and amateur bag limits;

i) limitations on the numbers of participants in the fishery;

j) improved handling to reduce sub-legal mortality;

k) protection of soft-shelled lobsters and berried females;

l) effective enforcement which provides a greater deterrent to illegal fishing;

m) effective compliance services, such as education, which encourages voluntary compliance; and

n) maximised voluntary compliance with fisheries laws by fishers.

FISHERIES 2030

52. In September 2009, the Minister of Fisheries released a strategy for the New Zealand fisheries sector, called "Fisheries 2030". *Fisheries 2030* sets a long-term goal of: *New Zealanders maximising benefits from the use of fisheries within environmental limits.* This goal encapsulates the Government's ideal or aspirational state for New Zealand's fisheries.

53. *Fisheries 2030* provides increased certainty about the government goal for the fisheries sector as well as defining the government's priorities in supporting the sector to achieve this long-term goal. The strategy addresses customary, amateur, commercial fishing and aquaculture interests as well as the interests of environmental stakeholder, non-extractive users, and government.

54. *Fisheries 2030* also contains two high-level outcomes, with an associated set of supporting outcomes, which describe the goal in more detail. The *Fisheries 2030* goal, outcomes and supporting outcomes are deliberately high level and are not intended to be used to determine actions directly. Rather, Fisheries 2030 sets the broad framework that forms the basis for, and drives management of, New Zealand's fisheries.

55. Objectives-based management through fisheries plans is one way in which the outcomes identified in Fisheries 2030 will be achieved. MFish is currently developing a National Inshore Shellfish Fisheries Plan (of which rock lobster is a part). During 2011, it is proposed that MFish will work with the NRLMG to discuss the performance of rock lobsters fisheries and

service needs to ensure management objectives, which are specified in the Fisheries Plan, are met.

6. SUMMARY OF RESEARCH ACTIVITIES

2010 ROCK LOBSTER RESEARCH PROGRAMME

56. In 2010 the NZ RLIC, in collaboration with sub-contracted stock monitoring and stock assessment providers, completed the final sequence of the three year CRA 2006-01 research contract and commenced the first of the new CRA 2009-01 contract. These contracts incorporate extensive stock monitoring coverage, stock assessments, and the maintenance and development of management procedures incorporating harvest control rules.

57. Stock assessment scientists presented a new CRA 5 stock assessment, developed and operated options for a CRA 5 Management Procedure and presented a revised CRA 7 Management Procedure. They also operated the CRA 3, CRA 4, CRA 7 and CRA 8 Management Procedures used to guide statutory TAC setting in these fisheries. These activities resulted in the management proposals set out in the statutory consultation paper (Annex 3).

58. Stock assessment scientists also operated the CRA 5 industry Management Procedure developed to guide stakeholder decisions on voluntary commercial catch limits; and reported a preliminary evaluation of a management procedure option for CRA 9.

59. NIWA continued the annual monitoring of rock lobster larval settlement. Work continues to attempt to establish correlation between settlement and future abundance that may be useful to inform management responses in anticipation of seasonal variability in stock abundance.

Stock Monitoring

60. Industry logbook data from CRA 2, CRA 5, and CRA 8 continue to be incorporated into the stock assessment process. These programmes are supported by commercial lobster fishermen who measure and record all rock lobsters in four designated pots each fishing day. The data, which are designed to be representative of the respective fisheries, are providing reliable and consistent information for stock assessments. During 2010 electronic logbooks were introduced for use by selected CRA 2 commercial fishermen.

61. Sequences of stock monitoring are undertaken as Fisheries Research Services in CRA 1, CRA 2, CRA 3, CRA 4, CRA 5, CRA 7, and CRA 8. Tag and release sequences were conducted in CRA 1, CRA 4 and CRA 4.

62. Industry-funded technicians and administrative support staff continue to be employed in the Bay of Plenty, Canterbury-Marlborough, Chatham Islands, Otago, and Southern rock lobster fisheries.

63. Regional administrative and support staff are contracted and supervised by the regional commercial stakeholder organisations (CRAMACs) or the NZ RLIC on their behalf. The NZ RLIC contracts Trophia Research to maintain the CRA Logbook database and to analyse and report logbook data to participants and to the annual assessment process. The CRA 2 Rock Lobster Management Company (CRAMAC2) has contracted Lat 37 Ltd to manage the electronic logbook (*ELVIS*) database.

Research Planning

64. In 2010 MFish again designated the NRLMG as the forum for the Rock Lobster Research Planning process. This process contributes to the MFish Business Plan. The NRLMG was selected as a model for fisheries research planning groups because of its multi-sector representation and participation, and the degree of recognition given by the Minister when seeking sustainability advice.

65. The NRLMG sought and actively encouraged additional participants to the Rock Lobster Research Planning process that commenced in August and concluded with the Research Co-ordinating Committee submissions in September/October 2010. These included interest groups not directly represented on the NRLMG, and potential service providers.

66. The initial focus was to identify the information needs for rock lobster fisheries. The planning process also took account of the research projects in progress during the period January 2008 to March 2011.

67. The NRLMG has previously confirmed a range of immediate and medium term research needs, the results of which will inform the Minister when making sustainability decisions, and may assist stakeholders wanting to develop and implement Fishery Plans.

68. The projects that are considered essential to the stock assessment and modelling, to the management procedures including harvest control rule evaluation and analysis, and to management decisions are:

a) stock assessment;

b) stock monitoring; and

c) better non-commercial catch estimates including estimates of illegal removals.

7. STOCK ASSESSMENT OVERVIEW

INTRODUCTION

69. For 2010, the NRLMG identified two specific projects for the stock assessment Objective of the research contract: i) a CRA 5 stock assessment and ii) a CRA 5 management procedure development and evaluation. The stock assessment science team undertook these projects in a five-week workshop in September-October 2010. The technical work was overseen by the RLFAWG (chaired by MFish), which discussed and approved data and assumptions which were used in the assessment; and the modelling decisions that were made.

70. The stock assessment for CRA 5 used the purpose-built rock lobster model and five sets of fishery and biological data. The stock assessment showed the CRA 5 stock to be well above all sustainability reference levels and likely to remain above those them at current catch levels. Evaluation of alternative management procedures for CRA 5 was based on the stock assessment model results and a set of management procedures that would all produce safe and productive management of the CRA 5 fishery were presented.

Management Procedures and Harvest Control Rules

71. Harvest control rules for rock lobster fisheries were first implemented following agreement by the Minister in 1997. Decision rules for rock lobster fisheries were first implemented in 1993.

72. Generically the main benefit of harvest control rules and management procedures is that they enable the Minister's legislative obligations to be met in relation to sustainable utilisation while providing greater certainty to stakeholders over future management interventions.

73. Specifically, the benefits of harvest control rules are that:

a) they allow users to plan rationally;

b) they force stakeholders and managers to define management goals clearly;

c) they force stakeholders and managers to agree on data used in making decisions;

d) they force stakeholders and managers to establish clear rules in advance to guide management interventions;

e) they incorporate uncertainty into the decision making process formally and objectively; and

f) they may act to increase the user's understanding and acceptance of decisions.

74. There are currently two types of decision rules in operation. One type is the rule for the NSN and NSC substocks which provides guidance, based on commercial CPUE, on when stock assessments should be undertaken. The decision rule does not provide guidance on management interventions, except that TAC changes should not be considered unless CPUE is significantly different from that in the reference year. The decision rules for NSN and NSC substocks were constructed to allow for increases in TACs where rebuild would not be significantly delayed by taking such an action. These two decision rules are not harvest control rules. When a management procedure is adopted for CRA 5, the NSC decision rule will be obsolete.

75. The other type of rule is the CRA 4 management procedure, which specifies the exact TACC that should be set, based on an input value for CPUE, subject to minimum and maximum change rules. Under this type of rule, agreement is obtained among managers and stakeholders when the management procedure is designed: they agree about the data inputs, the harvest control rule and the period for which the management procedure will be used. Such rules are extensively tested with computer simulations. The application of these management procedures results in management action consistent with the Minister's legal obligations.

76. Examples of the second type of rule include the management procedures for CRA 7 and CRA 8 and their predecessor, the NSS decision rule, the CRA 4 management procedure and the agreed CRA 3 and CRA 4 management procedures. The 2002 NSS Management Procedure was extremely effective in achieving its stated objective of rebuilding the CRA 7 and CRA 8 stocks within a specified time. It allowed four TAC changes to occur with high consensus and minimum controversy, and reduced the requirement for frequent stock assessments of these two stocks.

Objective Performance indicators

77. Performance indicators are used to compare rulers during simulation testing, and they incorporate the goals for the fishery. Common indicators and goals are:

a) yield is measured by catch (customary, recreational, illegal and commercial catches), catch limits and the risk of falling below a threshold catch limit. A fishery goal could be to maximise annual catch, but this is not a goal in rock lobster fisheries in New Zealand.

b) stock abundance is measured by CPUE. A goal might be to maintain high abundance, because there are economic, biological, and social benefits of high catch rates.

c) stability is measured by the frequency of catch limit adjustments and the average size of changes (average annual variation). A goal might be to minimise change.

d) safety is measured by the risk of stock abundance falling below critical threshold levels. A goal might be to maintain high safety (low risk).

e) diversity is measured by the range of sizes available in the catch. The goal might be to maintain high diversity so that fishermen are able to respond to changes in market demand.

f) time to rebuild, for depleted stocks, is measured as the median year in which the stock has reached its target. A goal might be to rebuild within a stated period.

Reference points

78. The Act requires the Minister to set a TAC that moves the stock towards, or maintains the stock at, a level at or above *Bmsy*. *Bmsy* is not straightforward to estimate and is uncertain when estimated.

79. In the absence of a reliable Bmsy estimate, alternative and proxy targets are used. For some rock lobster stocks, these are "empirical" reference points (*Bref*) based on the history of the fishery. These are described in *The Guidelines for Harvest Strategy Standards* (MFish 2008) concept as follows:

"Conceptual proxies for BMSY, FMSY and MSY are qualitative surrogates that can be used in the absence of adequate information to directly estimate these reference points themselves. The conceptual interpretation embraces the spirit and intent of section 13 of the Act. It can be used in cases where there is insufficient information to estimate BMSY, FMSY or MSY explicitly, or where such estimates may be unreliable because, for example, there is little or nothing known about the stock recruitment relationship. Conceptual BMSY: In cases where the relationship between CPUE and abundance can be assumed to be more or less proportional, or where some other form of relationship has been derived from data, it may be reasonable to select an appropriate historical period when both CPUE and catches were relatively high and to use this CPUE level as a target. *The best example in current use in New Zealand is that for rock lobster*." [emphasis added]

80. The choice of reference period is perforce arbitrary and open to debate. When selecting reference periods the RLFAWG and the NRLMG consider a number of important factors:

a) a period for which good data are available from which to estimate vulnerable biomass;

b) a period during which the fishery is well developed, but by no means fully developed – the fishery has continued to produce catches after the end of the reference periods; and

c) a period in which the biomass was relatively stable (this is often difficult).

81. *Bref* is neither the highest nor lowest biomass level that has been experienced and observed in the fishery. In every case where *Bref* is used, stock abundance has fallen lower than *Bref* and then recovered.

82. Current practice is to consider also *Bmin*, which is the lowest stock abundance in the observed history of the fishery. In all stocks, the abundance has recovered from this low point. The probability of being below *Bmin* should be small (less than 5% or 10%). In simple terms the stock at limit *Bmin* is an undesirable stock status.

83. Finally, spawning stock abundance is considered, for New Zealand fisheries generally, an important reference point associated with safety.

84. When assessing the status of a stock, the RLFAWG compares the estimated stock size against these various reference points. Except for spawning biomass, they are based on "vulnerable biomass": the biomass that is legally available and vulnerable to the fishery in the AW season (i.e., at or above the MLS, excluding berried females, and taking gear selectivity and seasonal vulnerability into account).

85. The NRLMG has tended to view *Bref* as a "target" reference point because, in the absence of estimated *Bmsy*, it provides credible and practical benchmarks of sustainability and exploitation against which management actions that are consistent with legislative obligations can be recommended to the Minister.

8. UNCERTAINTY IN ESTIMATES OF TOTAL REMOVALS

Overview

86. Accurate information about total removals is necessary to enable appropriate management decisions to ensure sustainability. Information on the level of commercial removals is collected by the QMS reporting system. However, the infrastructure for collecting information on amateur, customary, and illegal removals is poorly developed.

87. The lack of accurate information on non-commercial and illegal catch contributes to the uncertainty of the stock assessment, detracts from the effectiveness of agreed harvest strategies and undermines the incentives created by the QMS.

88. In the case of rock lobster fisheries, to allow any or all of the individual catch components to increase without control will jeopardise the rebuild strategy and erode existing harvest rights and opportunities. No control is possible if catch components are unknown. No effective control is possible if catch components are uncertain.

89. Because some catch projections in stock assessments are made under the assumption of constant catches fixed at levels used in the assessment, an increase in future catch levels would result in an increased probability of a decrease in biomass and likely lower future biomass.

90. Significant uncertainty is associated with non-commercial removals from rock lobster fisheries. This situation has potential to confound the reliability of stock assessments, and to confound the expectations for, and to compromise the implementation of, Management Procedures, regional harvest initiatives and Fishery Plans.

91. In the case of those stocks generally regarded as “shared fisheries”, or those where stock abundance is less than optimum and high levels of non-commercial fishing activity are evident, the need for reliable and credible non-commercial catch data is urgent.

Customary Harvest

92. There is minimal information on customary non-commercial harvest even though customary fishing regulations have been promulgated. In the South Island the Fisheries (South Island Customary Fishing) Regulations 1999 came into force on 20 April 1998. Customary fishing regulations for the North Island and Chatham Islands, the Fisheries (Kaimoana Customary Fishing) Regulations 1998 came into force on 1 February 1999. The regulations become effective in different areas as nominated representatives of the tangata whenua are appointed. Uptake of the North Island and South Island Customary Fishing Regulations has been slow. However, MFish has in recent years provided more resource to inform and educate tangata whenua about the Customary Fishing Regulations, and to encourage

discussion where disputes about boundaries exist. This has resulted in greater uptake of the regulations, particularly on the east coast of the North Island.

93. The North Island and South Island customary regulations provide for quarterly reporting of permits issued for customary fishing purposes. Information derived from those permits is intended to improve the estimates of the level of customary harvest and although all available information has been presented to the RLFAWG there is no information available from areas still managed under Regulation 27.

Amateur Harvest

94. MFish telephone, diary, and ramp surveys have provided some amateur landing data from which estimates have been derived. Estimates of amateur harvest exist only for recent years and the results of the amateur catch surveys commissioned by MFish in 2000 remain highly uncertain and are not used in stock assessments. They were rejected by the RLFAWG. For the most recent rock lobster stock assessments the RLFAWG has assumed amateur catches and the trends in those catches over time.

95. MFish has sought tenders for research contracts aimed at improving recreational harvest estimates for rock lobster.

Illegal Take

96. The level of illegal removals from NZ rock lobster fisheries is estimated to be 372 tonnes nationally.

97. Illegal estimates were last amended in 2005 (but the estimates for some stocks are much older than this). At that time MFish Compliance provided updated point estimates of 'unreported' illegal removals, and advised that "*MFish does not currently have a reliable robust and defensible methodology to estimate illegal fishing. Our approach uses the 'method' employed in 2004 to provide information on the CRA 3 fishery*." In 2004, MFish Compliance had advised that "*Difficulties arise in trying to verify and cross check the figures provided and this is a limiting factor of the methodology. Therefore, estimates cannot be verified and have an associated low level of confidence*."

98. Estimates of illegal take, and associated historical pattern, are consequently highly uncertain. The RLFAWG has very little confidence in them.

99. Phase One of MFish's "Illegal Estimates Project" has now been completed. This focused on identifying existing methods and processes that could be used as the basis for a method to improve estimates of illegal take. Phase Two of the project is subject to internal processes to access research funds.

100. The timeline for completing this project is unknown.

In Summary

101. The NRLMG notes:

a) that accurate and reliable data for all sectors are essential to the stock assessment process;

b) that accurate and reliable data for all sectors are essential to the fishery management decision making process, particularly in circumstances where catch reductions are considered necessary to maintain or improve stock abundance;

c) that sufficient resources must be deployed to monitor non-commercial removals from rock lobsters fisheries to maintain the integrity of the TACs set for stocks, to maintain the integrity of the allowances made to extractive users within the TACs, and to maintain the fishing opportunity associated with those allowances;

d) that increased emphasis should be placed on the full implementation of the North and South Customary Regulations.

9. COMPLIANCE AND ENFORCEMENT ISSUES

Illegal Removals

102. The NRLMG has consistently stated over many years that reduced illegal fishing activity will facilitate attainment of the goal of the framework for managing rock lobster fisheries and improve harvest opportunities for legitimate extractive users.

103. Industry, customary, and amateur fishing representatives on the NRLMG have consistently expressed the view that Government should make a greater contribution to the existing Compliance budget and therefore enable more resources to be deployed into minimising illegal removals from the rock lobster fisheries.

104. Industry, customary, and amateur fishing representatives on the NRLMG agree that better compliance could be attained if rock lobster compliance strategies were developed and implemented.

105. MFish representatives on the NRLMG believe that these strategies can be further developed by stakeholders and MFish within the Fisheries Plan process.

In Summary

106. The NRLMG notes:

a) the significance of the illegal catch component and its negative effect both on the stock and on legitimate extractive users;

b) that all user groups recommend that the Minister takes steps to ensure that compliance strategies and services (including enforcement and education services) are sufficient to minimise illegal catch;

c) that sufficient resources must be deployed to constrain illegal unreported removals in the first instance to the levels of the allowances made in setting TACs, and ideally to much lower levels so as to improve the quality of the fishing experience to be enjoyed by legitimate users.

10. ROCK LOBSTERS

107. The spiny rock lobster (*Jasus edwardsii*; koura) has always been important to Maori and for much of this century has supported increasingly important commercial and amateur fisheries. Rock lobsters support one of the country's oldest commercial fisheries, and are one of the seafood industry's top export earners.

108. The commercial fishery has developed through a number of phases as catches have increased with the development of export markets. Management of the resource has changed in response to the changing status of the stocks and the expectations of stakeholder groups.

109. Since 1990 the rock lobster fishery has been managed within the Quota Management System (QMS) and governed by a mix of output controls and fishery regulations, including the provision of a minimum legal size, a prohibition against taking berried females and soft-shelled animals, method restrictions, the requirement that all pots be fitted with escape gaps, and closed seasons in some areas.

110. The current management of the rock lobster fishery is focused on moving stocks to agreed biological reference points and maintaining them at this level or above, primarily through the adjustment of Total Allowable Catches (TACs).

THE RED ROCK LOBSTER AND ITS NATURAL HABITAT

111. Lobsters are strictly marine. They all have the same basic body plan (head, tail, 2 pairs of antennae, no less than 6 pairs of mouthpart appendages and 5 pairs of legs.

112. 'Crayfish' or 'Cray' are strictly freshwater and are clawed, i.e., New Zealand's Koura. Unfortunately 'Cray' is a common term used for New Zealand's marine lobsters. Koura is the general Maori name for both (freshwater) crayfish and (marine) lobsters.

113. New Zealand has four species of rock lobsters (spiny lobsters), the most common of which is the Red Rock Lobster (*Jasus edwardsii)*. In Australia this species is known as the 'Southern Rock Lobster'.

114. The other species found in New Zealand are the:

a) Packhorse Rock Lobster /Green Rock Lobster. (*Sagmariasus verreauxi)*. This lobster is less than 1% of commercial rock lobster landings. It is the world's largest rock lobster.

b) Deepwater Rock Lobster (*Projasus parkeri*) is taken occasionally as incidental catch from trawling but is not marketed.

c) a tropical rock lobster species (*Panulirus sp*.) found only at the Kermadec Islands.

115. The Red Rock Lobster is dark red and orange above, paler and yellowish below. The body is spiny, especially on the head. They can weigh up to 8 kg and reach lengths of about 60 cm (excluding the feelers).

116. In contrast the Packhorse lobster is green; has a distinctive 'carapace' (the protective shell of the head and thorax). The Packhorse's carapace has a distinctive shape at the front part and distinctive patterns of spines. The Packhorse also has a lack of sculpting on its tail. As the world's largest rock lobster it has been found to weigh up to 20 kg and reach lengths of 70 cm.

117. The deepwater rock lobster has a distinctive apricot colour, two prominent rows of spines on its carapace and a central ridge along the top of its tail. It is a much smaller rock lobster reaching lengths of 25 cm.

118. The tropical rock lobster species is a medium sized species of the western pacific. They have a distinctive structure at the base of each feeler that produces a sharp, rasping sound when the feelers move.

Habitat and Behaviour

119. Very small lobsters usually shelter alone in small cracks or holes. As they grow they become more gregarious and can be found in groups of 50 or more. This behaviour helps to protect them from predators. Once they become sexually mature their willingness to share dens varies seasonally especially for males (see section on reproduction).

120. During the day Red Rock Lobsters are normally found in rock crevices (dens), which provide shelter from predators, storms, and the sun. They generally leave the dens around dusk to forage for prey, returning just before dawn

121. The deepwater rock lobster is a very deepwater lobster, found between 500 m and at least 900 m.

Distribution

122. The red rock lobster is found throughout New Zealand, on seamounts in the Tasman Sea and around southern Australia. In New Zealand they are found from the Three Kings Islands in the north all the way to the Auckland Islands in the south and to the Chatham Islands in the east. They are also found on shallower seamounts to about 300 m depth throughout New Zealand's Exclusive Economic Zone. The red rock lobsters found at the Auckland Islands are the southern-most rock lobsters in the world.

123. Packhorse rock lobsters are widely distributed, as far north as the Kermadec Islands, south to Foveaux Strait, and east to the Chatham Islands. They are fished mainly in the far north of New Zealand. (They also occur in eastern Australia – northern Victoria and New South Wales - where they are commonly called the Eastern Rock Lobster).

124. The deepwater rock lobster is widespread in the southern oceans. The species is most commonly found in the Bay of Plenty, off the Wairarapa coast and across the Chatham Rise.

ANATOMICAL FEATURES OF RED ROCK LOBSTER

External Features - location and identification

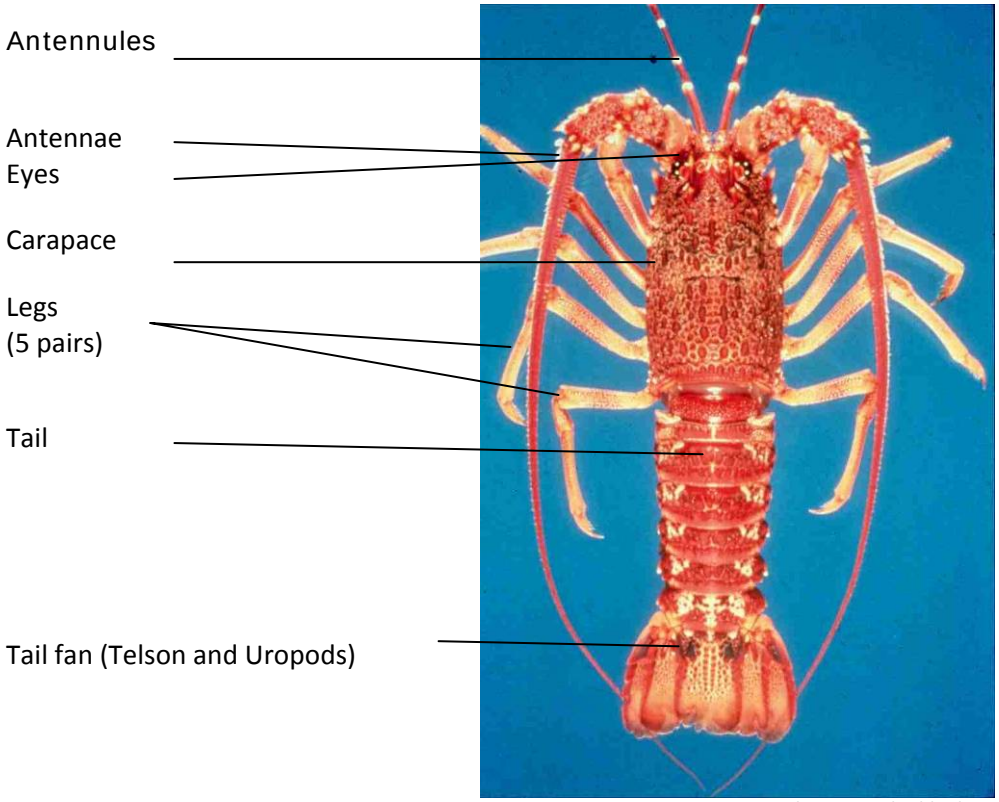


Photo: A. Blacklock

External features and their function

External Feature	Function
Eye	Compound eyes at the tip of the eye stalks
Antennae	Long "feelers" that can be rotated around to fend off predators. They also have some sensory function.
Antennules	The short slender appendages are capable of detecting food (tasting), danger, and pheromones
Legs	5 pairs of legs used for walking and feeding
Carapace (or cephalothorax, the head & thorax)	Protection of vital organs such as the liver, stomach, gonads, gills and heart by the exoskeleton case
Tail (or abdomen)	Consisting of 6 separate, moveable parts, plus the tail fan (telson and uropods). The main muscle for movement (swimming) away from danger. Under the tail are paired feather-like appendages (pleopods).

Internal Features – location and identification

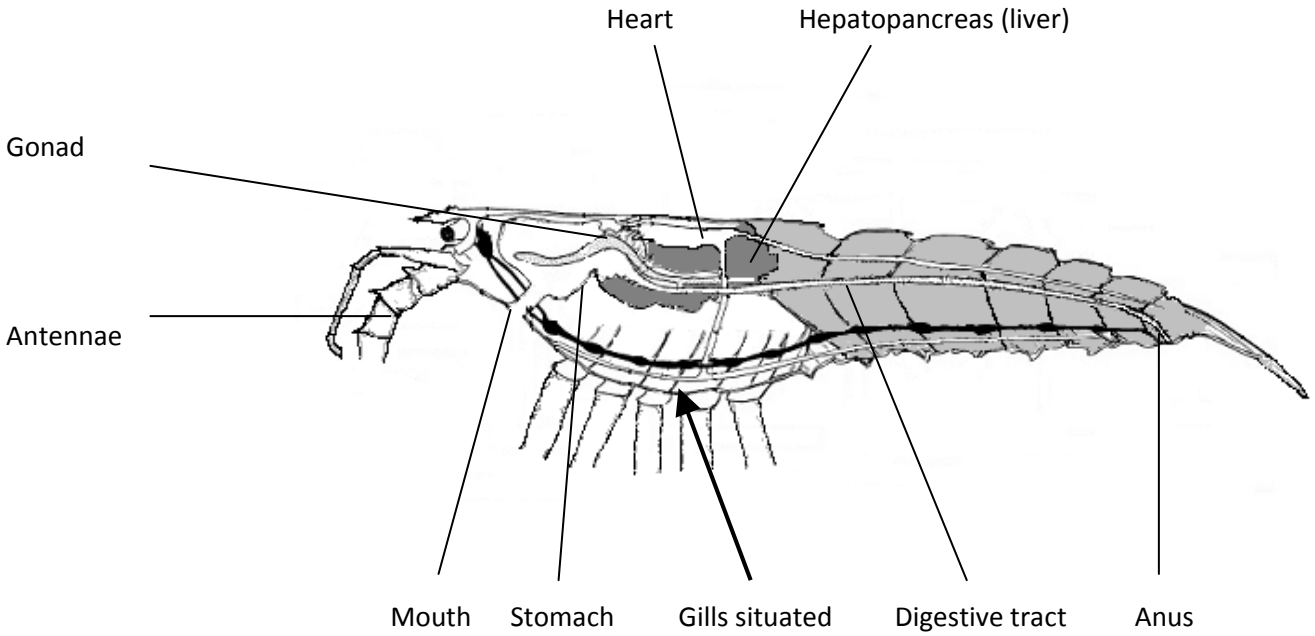


Illustration: G. Moss

Internal Feature	Function
Mouth	The mouth is for the ingestion of food. It has a series of appendages associated with it that help bring the food to the mouth and crush it before ingestion.
Gills	The gills, which sit under the carapace at the base of each leg, are used for the uptake of oxygen from the water and release of carbon dioxide
Heart	The heart pumps the blood around the body of the lobsters
Gonad	The gonad produces eggs or sperm for reproduction.
Hepatopancreas (or liver)	The hepatopancreas (or liver) produces the digestive fluids which break down the food that is eaten
Digestive track	The digestive tract is used to absorb the nutrients from the food
Anus	The waste products of digestion are excreted through the anus

Sexual differences

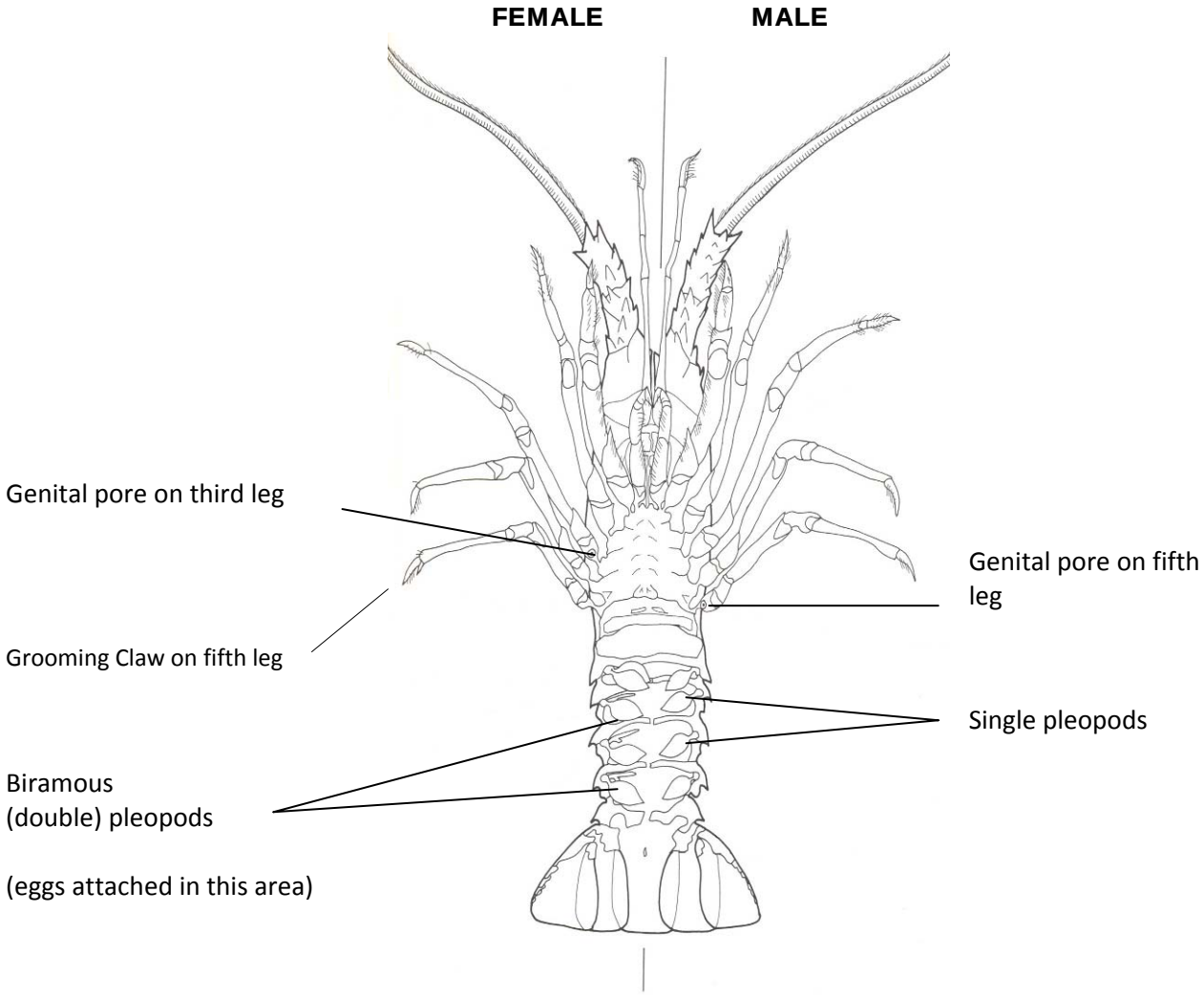


Illustration: P. James

Difference	Function
Genital pores	**Females**. Positioned on the base of the 3rd walking leg for females so the eggs are extruded and pass through the sperm package the male deposits on her abdomen before attaching to the pleopods **Males**. Positioned on the base of the 5th walking leg for males so the sperm package is deposited below the female genital pores
Grooming claw	Present on the 5th leg of the **female** only, it is used for grooming the eggs when they are attached to the pleopods Not present on the **males**
Pleopods	**Females** have biramous (or double) pleopods. The innermost branches of the pleopods are covered with long hairs for the attachment of the eggs. The female keeps the eggs aerated by slowly beating her pleopods. **Males** have single pleopods

Feeding, Reproductive Cycle and Life Cycle

Food and feeding

125. Lobsters feed on a wide range of small shellfish, crabs, starfish and kina, depending on local availability. They generally hold the prey with their front legs and crush it in their mandibles (or mouthparts).

Photo: A Blacklock

Moulting and mating

126. Female lobsters can only mate when the carapace is soft (i.e. within a few weeks of moulting). Red rock lobsters moult as early as late February in southern waters, but not until late June in warmer northern waters, and shortly after moulting (2 hours to 63 days) do they mate [2]. Lobsters are selective about who they mate with; large males prefer to mate with large females and females also prefer the largest male available.

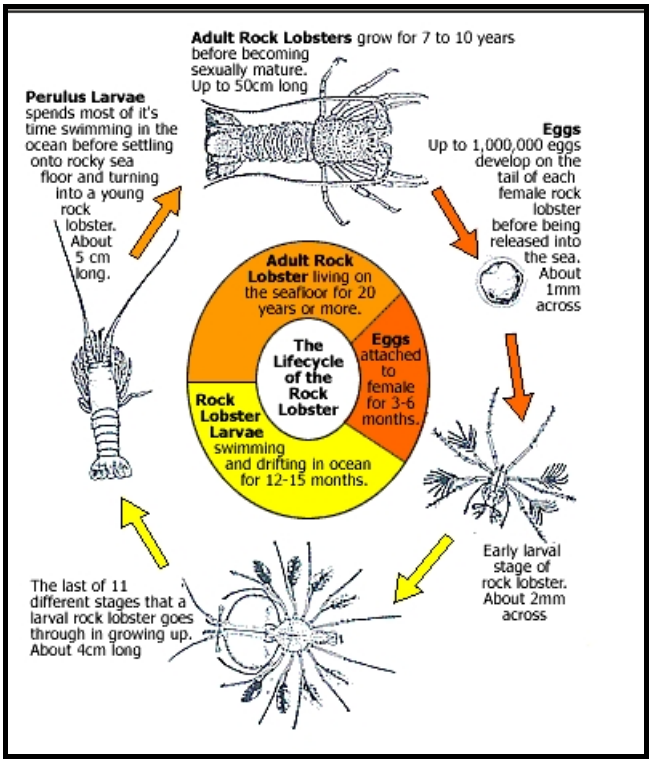
127. Once a mate has been selected the lobsters begin courtship which may last just a few minutes or several days. When they are ready to mate they rear up, belly to belly and embrace before toppling over with the female uppermost. The male then deposits a sperm package (or spermatophore) onto the belly of the female.

128. The sperm package begins to disintegrate immediately, so the female rapidly starts to extrude her eggs. Normally she will cling to a rock face head up and form a brood chamber with her tail, spreading the tail fans to cover the genital pores and the sperm mass. Eggs are extruded from the genital pores and fertilised as they pass through the sperm package before attaching to the long hairs on the pleopods, under the tail. Small females may extrude as few as 20,000 eggs while large females may produce up to half a million. The fertilised eggs are carried for between 3 and 5 months, before hatching.

129. Large males become aggressive during the mating season, which usually results in one male per den. Females are also less likely to shelter together during mating when they are competing for the large males.

Berried female with newly deposited eggs under her tail Photo: A. Blacklock

LIFE CYCLE OF RED ROCK LOBSTER



ROCK LOBSTER LIFE CYCLE Source: MFish 2005

Life Cycle Summary

a) Lobsters have a long and complex life history

b) The adults mate and the females carry eggs (berried) for 3-5 months

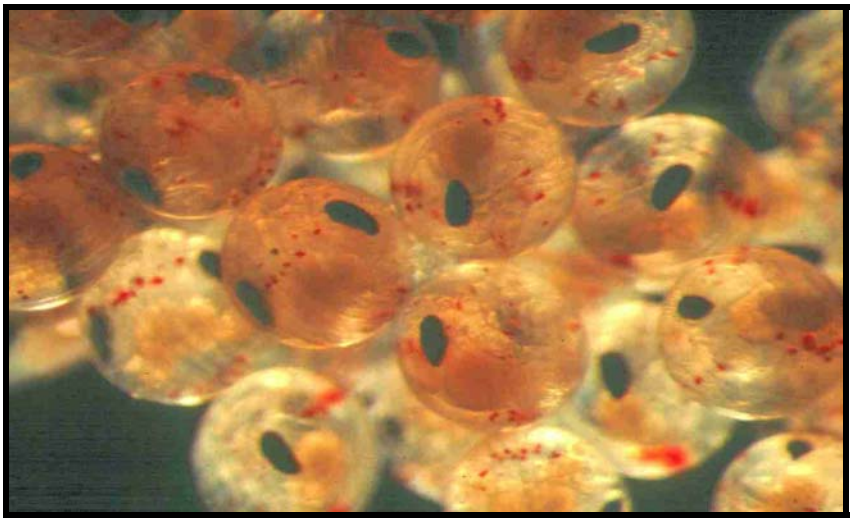
c) Larvae hatch and swim in the open ocean for 18-24 months, during which they undergo numerous moults and changes (11 phyllosoma stages)

d) The puerulus stage settles and moults into the juvenile stage

e) Juveniles mature and become adults after 4-5 years

Eggs and hatching

130. Females carry the eggs under the tail for 3-5 months. During this time the female keeps the eggs aerated by slowly beating the pleopods and groomed using small pincers on her rear walking legs. The embryos in the eggs develop through a number of stages, developing prominent eyes and legs (below), before becoming ready for hatching [3].



Well developed eggs just prior to hatching *Photo: L. Tong*

131. Hatching occurs at daybreak during the spring. The female stands on tips of her legs with her tail held upright into the water current. She vigorously beats her pleopods for a few seconds, which releases a swarm of the first larval stage (naupliosoma). The eggs hatch into spider-like larvae which drift in the water for 12 -15 months, growing to around 50 mm in length before returning to inshore areas to settle on the seafloor.

Larval stages

132. Naupliosoma larvae swim up to the light and within minutes moult into the transparent second stage Phyllosoma larva (below left). This small spider like creature has a body about 2 mm in length.

133. The phyllosoma stages are carried seaward by ocean currents and spend the next 18-24 months growing through eleven phyllosoma stages and seventeen instars, up to 1000 km

from the shore. The long larval life and poor swimming of the phyllosomas mean that they get carried about by currents and caught up in eddies.

Phyllosoma Larva in 2 different stages

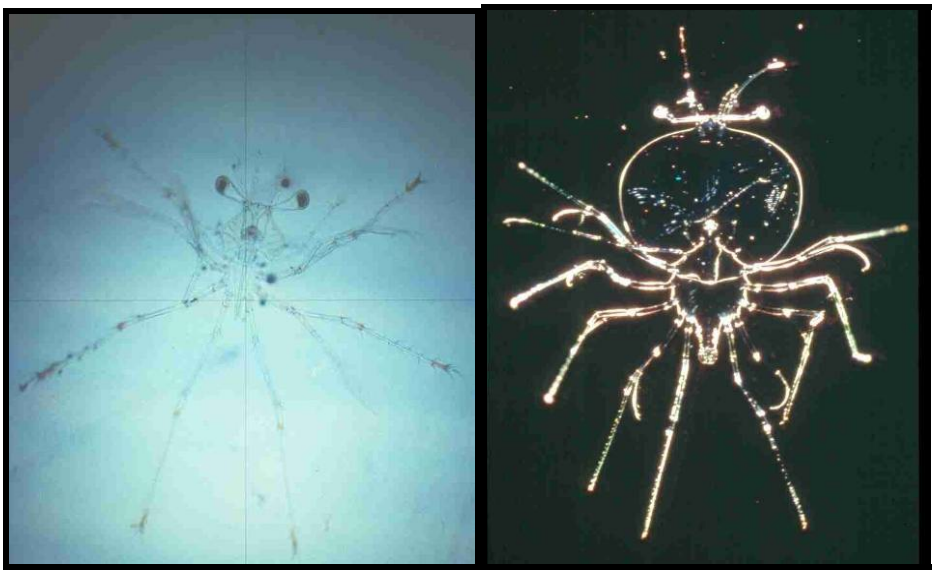
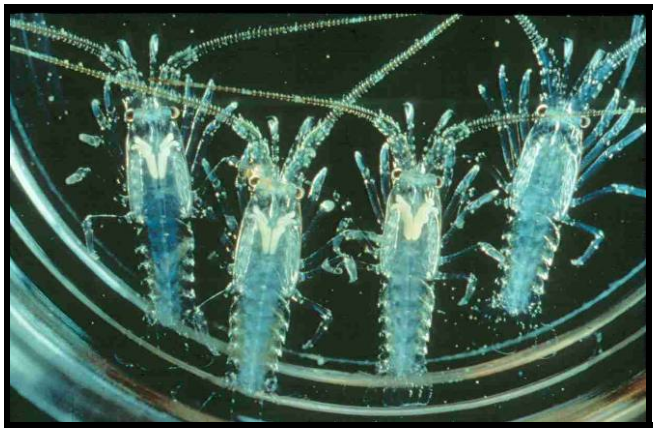


Photo: G. Moss *Photo: A. Blacklock*

134. When they reach about 35-50 mm, the leaf-shaped phyllosomas (above right) metamorphose into the puerulus stage.

135. Pueruli look like small (25 mm) transparent juvenile lobsters (below). They are good swimmers and can swim up to 150 km to the shore. During this stage they do not feed and survive on fat stores laid down by the phyllosoma stages.



Puerulus stage *Photo: A. Blacklock*

Settlement, juvenile stage

136. Pueruli that successfully reach the shore, settle into small holes and crevices on shallow reefs and within 2-3 weeks moult into the juvenile stage and start to feed. Juveniles mature and become adults after 4-5 years.

Moulting and growth

137. Lobsters have a hard shell (or 'exoskeleton') and in order to grow they must shed this shell (below) and replace it with a bigger one.

Intact moult from a juvenile lobster Photo: G. Moss

138. Before moulting ('ecdysis') the lobster begins to grow a new layer of exoskeleton beneath the old shell and begins to remove calcium from the old skeleton. When the lobster is ready to moult the membrane on the back of the lobster, between the carapace and the tail, splits and then the animal pulls itself out of the old shell. The lobster then takes up water, to swell up and enlarge the new shell, before re-depositing the calcium and hardening the new shell.

139. This process of shedding the shell (or 'moulting') occurs frequently in small lobsters (4-6 weeks) when they are growing rapidly but usually occurs once a year in adult lobsters. The amount of growth is dependent on the size of the lobster the temperature of the seawater in which it has been held and the amount and type of food it has eaten.

Migrations

140. In spring and early summer some juveniles migrate against the prevailing current. It is believed these migrations help counter the effect of downstream larval drift. Adult lobsters undertake seasonal inshore-offshore movements associated with moulting, breeding and feeding.

Size at onset of maturity

141. The size at onset of maturity for female rock lobsters, *J. edwardsii*, has been defined as the size or size class at which 50% of the rock lobsters in a sample are mature. Animals are regarded as mature if they are bearing external eggs attached to the pleopods or if there are well developed setae on the endopodites of the pleopods.

142. Immature females usually moult twice a year until maturity, then annually. Where size at 50% maturity is large, some females may begin moulting once a year before maturity.

143. The size at which 50% of females are mature varies considerably for *J. edwardsii* throughout New Zealand, from 72 mm Carapace Length (CL) near Gisborne to 121 mm CL in eastern Foveaux Strait. This size appears inversely related to water temperature. No data are available from the Chatham Islands.

144. Size at 50% female maturity in most areas is less than the minimum legal size of 60 mm tail width (TW) (approximately 93 - 98 mm CL). Most females from these areas breed at least once before reaching the minimum legal size. However, from Banks Peninsula through western Foveaux Strait (CRA 7 and part of CRA 8), size at 50% maturity is greater than the minimum legal size. The effects of this are not known, but these areas have sustained high catches over time.

145. At sexual maturity the female lobster's pleopods increase in size and the inner branch grows a fringe of pale hairs to which the eggs attach after mating. The males mature at about the same size but there are no obvious external changes.

146. Most mature *J. edwardsii* females moult and mate some time between February and May. Females carrying eggs occur in greatest numbers from April to October, though a few are found during any month of the year. Females bear eggs only once each year and most mature females carry eggs during the egg-bearing season. Successful reproduction requires mature male and female lobsters of similar size.

147. The number of eggs carried by *J. edwardsii* depends on size, ranging from about 125,000 for a female of 95 mm carapace length (CL) to about 540,000 for one of 170 mm CL.

148. Most mature female *S. verreauxi* moult between July and November, bear eggs during late September to January, and hatch the eggs from December to January. The number of eggs carried by *S. verreauxi* ranges from about 375,000 for a female of 152 mm CL to 2,000,000 for one of 230 mm CL.

149. Rock lobsters of both species develop through a series of stages from egg to adult. Fertilised eggs are attached to pleopods (swimmerets) on the underside of the female's tail. The eggs develop for 3 to 6 months and hatch as small nauplisoma larvae. Within a few days these metamorphose into phyllosoma larvae, which develop through 11 stages during the 10 to 20 months they spend in the ocean. The last phyllosoma stage metamorphoses into the

puerulus larva, a strong swimmer that returns to the coast and moults into the first juvenile stage if it finds suitable substrate.

Larval Distribution and Recruitment

150. An extensive distribution of phyllosoma and puerulus larvae of *J. edwardsii* has been observed in areas along the east coast of the North and South Islands, and the Tasman Sea, to areas outside the EEZ boundary. Information on larval settlement patterns is available from several parts of the country.

151. Most late-stage phyllosoma larvae occur beyond the edge of the continental shelf to 1100 km from the coast. Larvae undergo diurnal vertical migration, moving into the top 150 m of the water column at night and dispersing in deeper water during the day. It is possible that late stage phyllosoma larvae delay metamorphosis to the puerulus stage, perhaps until they encounter an environmental cue such as lower salinity shelf water.

152. Puerulus larvae are most common in the plankton within the shelf edge. They are near the sea bottom during the day and rise in the water column at night. They have been observed to settle on the sea bed at depths to 10 m.

153. The puerulus settlement season varies with locality. Along the east coast of Northland and the Bay of Plenty the main settlement season is probably summer; from East Cape through Cook Strait settlement occurs in both summer and winter. Autumn appears to be the main settlement period in the north-east of the South Island; winter and spring are the main settlement seasons south of Banks Peninsula; year-round settlement is possible along the west coast of the South Island.

154. The highest larval settlements have been seen along the east coast of the North Island south of Matakaoa Point, the northeast and south coasts of the South Island and the north Taranaki coast.

155. Because of the long larval life, the origins of larvae are difficult to determine. Larvae hatched in one area may be retained in that area by local eddy systems carried to other areas by currents, or lost to New Zealand entirely. Eddy systems have been identified off the east coast North Island that may help to retain larvae within this area. However, for most areas larvae may originate a considerable distance from the settlement site.

156. The only known large breeding population of *S. verreauxi* is near Cape Reinga. The larval life is probably similar to that of *J. edwardsii*. The developing phyllosoma larvae are probably carried by the East Auckland Current towards the Bay of Plenty. The puerulus larvae probably settle out of the plankton at various sites along this coast. A few larvae may be transported south of East Cape, but most either settle out before reaching this area or are lost to the north-east, towards the Kermadec Trench.

Age and Growth

157. Rock lobsters, as do all crustaceans, increase in size by moulting. Growth rate is a function of both moulting frequency and moult increment. Because rock lobsters lack structures that would allow them to be aged, growth has been estimated from size-frequency distributions and tagging experiments.

158. Estimates of the growth rates for small *J. edwardsii* are available from the Gisborne area and Stewart Island. Males and females in Gisborne both reach about 38 mm CL one year after settlement and about 58 mm CL after two years. At Stewart Island, after one, two and three years they have reached 33 mm, 52 mm, and 68 mm CL.

159. Growth rates of larger animals have been estimated for a number of areas. The estimates of growth per moult, moult frequency, and annual growth vary between areas and between the sexes for the same area. The estimates come from ongoing tag release and recapture studies across most rock lobster management areas.

160. In most areas moulting is seasonal, with immature and mature animals of both sexes having their own distinct periods, which may vary between areas. Smaller males (between about 70 mm and 80 mm CL) from most areas generally moult twice a year. Large males moult once each year; very large males may moult even less often.

161. Information on the growth rate of *S. verreauxi* is limited mainly to animals between 120 mm and 159 mm CL. Males and females between 120 mm and 139 mm CL moult at least once a year, between July and November, and perhaps twice, with an increment of about 7 mm CL per moult. Animals between 140 mm and 159 mm CL moult once a year between July and November, with an average increment of about 6.8 mm and 6.0 mm CL for males and females respectively.

Movements

162. For management, the most important movements would be large-scale migrations or inshore-offshore movements. Extensive tagging of *J. edwardsii* has been conducted in many areas. In most areas fewer than 5% of the returns have moved more than 5 km. Such areas include Tauroa Point, Banks Peninsula, Gisborne, Wellington, and Fiordland.

163. Movement patterns in southern New Zealand appear to involve two groups of animals: “run” rock lobsters that migrate over long distances, and “resident” rock lobsters that do not. In most studies, only up to 4% of tagged lobsters moved significantly from the release site. However, when “run” lobsters were tagged, between 27.6% and 38.6% of recaptures showed long-distance movements.

164. The long-distance movements of *J. edwardsii* tagged in southern New Zealand tend to be directional: southward along the Otago coast and the east coast of Stewart Island, westward through Foveaux Strait and northward along the west coast of Stewart Island and the Fiordland coast, in opposition to the prevailing current systems. These movements also

appear to be seasonal, usually occurring off the Otago coast and through Foveaux Strait from September through November and along the Fiordland coast during November through January. Most migrating females are immature, moving from Otago and Foveaux Strait, which have a large size at 50% maturity to Fiordland, with a smaller size at 50% maturity. These movements may be a "contranatant migration" in which animals migrate against the current that carries the larvae.

165. The long-distance movements of *S. verreauxi* in northern New Zealand also appear directional. All but two recaptures tagged at North Cape moved to the west or southwest, most to near Cape Reinga. Of the female recaptures, only 10% were mature when tagged, but 80% were mature when recaptured. Only 10% of the females tagged at North Cape had setae on the pleopods, but 80% had setae when recaptured. This may be another contranatant migration, with juveniles at about the time of maturation near North Cape moving towards Cape Reinga, where the only large breeding population of this species is known.

166. There may also be a return movement towards the north against the prevailing current system along the east coast of the North Island by juvenile *S. verreauxi*. Most of the sublegal lobsters and immature females tagged between Bream Bay and Mahia moved north or west before recapture. Large numbers of sublegal animals are found on the east coast south of North Cape, but some legal-sized mature females are also found in this area. Thus juveniles from this area may also move towards Cape Reinga just before attaining sexual maturity.

Stock units and fisheries

167. The rock lobster fisheries extend from the Three Kings Islands in the north to the Snares Islands in the south, and to the Chatham Islands in the east. The main fishery is for *J. edwardsii* (CRA), which accounts for nearly all landings. There are currently ten quota management areas for CRA although one (CRA 10) is only an administrative designation and no fishing of any consequence is carried out there.

168. *S. verreauxi*; (PHC) is caught mainly in the north of the North Island and there is only one quota management area for all New Zealand waters.

169. Preliminary morphometric studies conducted on run and resident lobsters near Stewart Island show that the two groups can be distinguished on the basis of the telson length to carapace length ratio, but such differences may be environmentally induced.

170. The lack of genetic differences among areas, the long larval phase and long-distance movements of adults in some areas all suggest a single *J. edwardsii* stock around the mainland.

171. Recent stock assessments have addressed individual CRA areas (CRA 1 and CRA 2 in 2002; CRA 3 in 2001, 2004 and 2008; CRA 4 in 2003 and 2005; CRA 5 in 2003 and 2010; CRA 7 and CRA 8 in 2006).

172. For earlier assessments, the seven principle mainland areas were grouped on the basis of similarities in relation to size at maturity, the timing of biological cycles, and the perceived interchange between areas. CRA 7 and CRA 8 are designated the "NSS" sub-stock. CRA 1 and CRA 2 are called the "NSN", and CRA 3, CRA 4, and CRA 5 are called the "NSC".

173. Genetic and morphometric samples have not been collected at the Chatham Islands, and, because of their geographical isolation, the rock lobsters from this area are also treated as a separate stock for management purposes.

174. Genetic and morphometric samples have not been taken for *S. verreauxi*. Because of the limited distribution of mature females near Cape Reinga, and the highly directional movements of tagged animals to this area, the species is considered a single stock.

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Glossary of Terms

Term	Explanation
Carapace	The part of the shell that covers the head and body of the lobster
Carbon dioxide	The waste product of respiration it passes out of the gills. Carbon dioxide dissolves in water to form a weak acid
Compound eyes	An eye, like that of insects, made up of numerous separate light sensitive units.
Eddies	Currents of water that move in a circular motion, like giant whirlpools.
Exoskeleton	The hard external skeleton (or shell) of the lobster
Gregarious	Living together in groups
Maturity	When the lobster becomes an adult and is able to reproduce
Membrane	The skin covering a part of the body
Metamorphose	To undergo a complete change of physical form from the larval stage to the juvenile stage
Migrate	To move from one area or habitat to another
Moulting	The process of shedding the hard shell (or exoskeleton) in order to grow a new and bigger shell.
Naupliosoma	The first stage larva that hatches from the egg. It lasts only a few minutes before moulting into a phyllosoma
Phyllosoma	The majority of the larval stages of the lobster. Phyllosoma spend 18 months to 2 years floating (and swimming in the plankton).
Pueruli	The final larval stages of the lobster. Pueruli actively swim to shore to settle and become juvenile lobsters
Salinity	The amount of salt in the seawater. This can change in seawater with evaporation or inflow of freshwater from rain or rivers
Seamounts	Underwater mountains rising from the ocean floor

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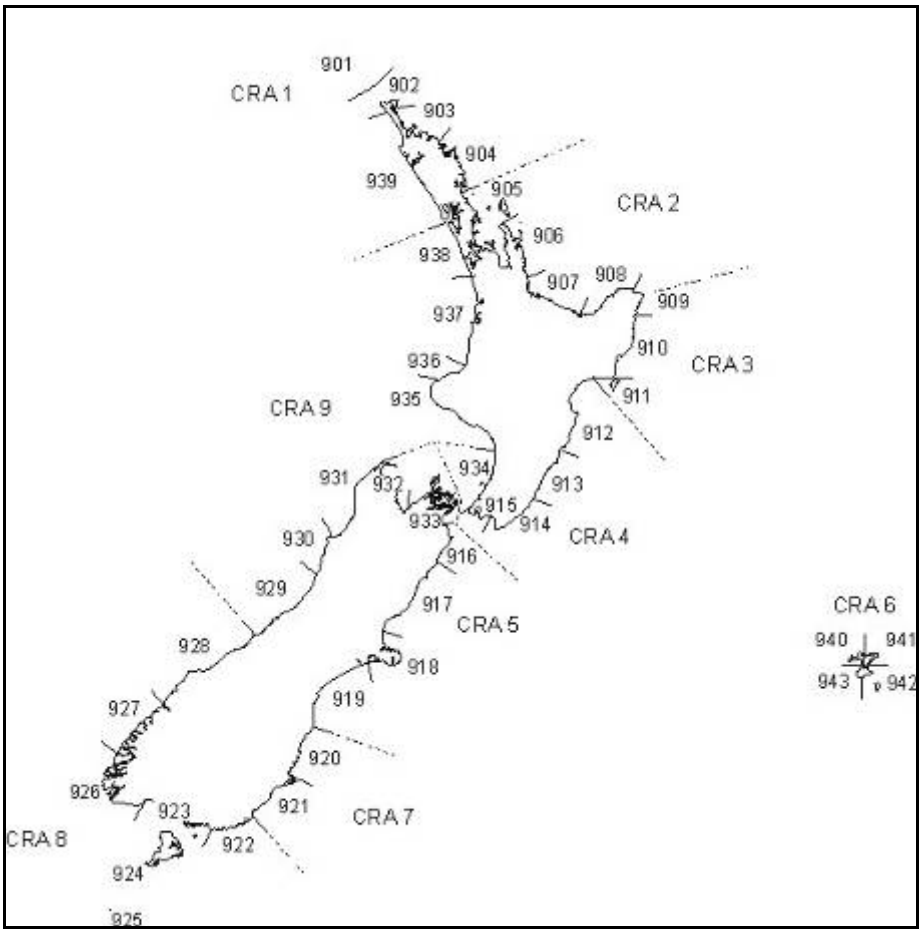
Additional Information can be found at: –

www.fish.govt.nz

www.nzrocklobster.co.nz

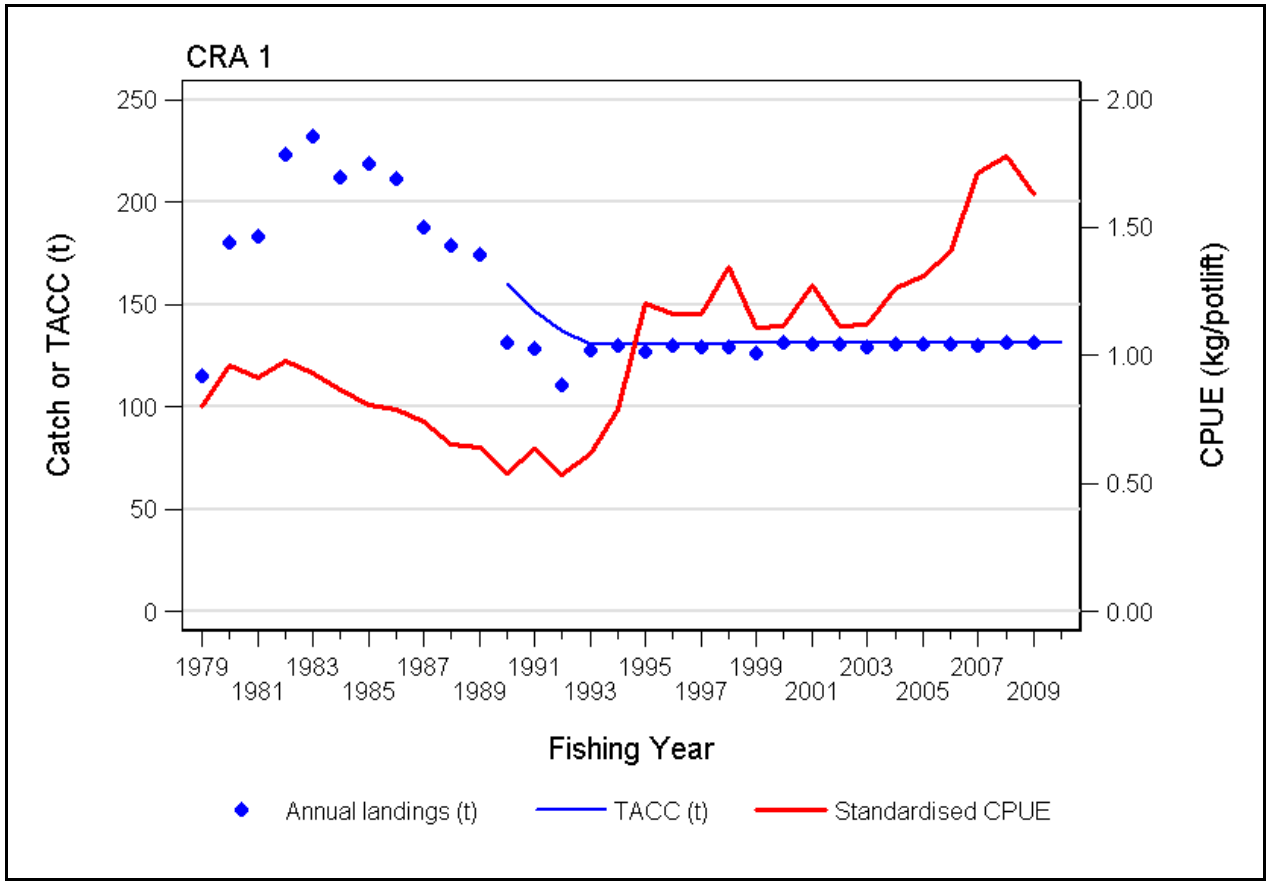
11. STOCK SUMMARIES

175. This section outlines the principal rock lobster fishing activities in each of the quota management areas and a brief summary of stock status taken from the most recent assessments.



Rock lobster fishery management areas (CRA 1 – CRA 9) and statistical areas used for commercial catch and effort reporting.

12. CRA 1



176. The CRA 1 fishery extends from the Kaipara Harbour on the west coast of the North Island around North Cape and then south to Waipu. The commercial fishery extends offshore to the Three Kings, but the bulk of the commercial harvest is taken from waters adjacent to the mainland. No TAC has been set for this fishery. The 131.062 tonnes TACC has remained unchanged since April 1998.

177. The last stock assessment for CRA 1 was made in 2002 (Starr *et al*. 2003), with the version of the Bayesian length-based rock lobster model used at that time. This was fitted to historical catch per day, daily CPUE, size data from market sampling, voluntary logbooks and observer catch sampling, and tag-recapture data. Changes in MLS and selectivity caused by escape gap regulations were taken into account.

178. The assessment used performance indicators based on biomass levels for the ten years 1979–88, a period during which biomass was relatively stable.

179. The assessment suggested that CRA 1 biomass (vulnerable biomass in autumn-winter) decreased to a low point in 1973, increased through the early 1980s, declined again until the early 1990s (but not as low as in 1973), increased strongly in the late 1990s and then declined to 2002. The assessment suggested that 2002 biomass was 150% of *Bref* (5% to 95% limits

130 to 180%) and that biomass projected over five years would stay roughly the same (but with high uncertainty, ranging from 35% decrease to 60% increase).

180. Since 1998 the TACC has remained the same, and since 2000 the TACC has been fully caught. As predicted by the stock assessment, CRA 1 CPUE showed little change for the five years after 2002, but the 2009 CPUE was 46% higher than in 2002, suggesting a recent increase in stock abundance. Combined with the previous assessment, this suggests a stock well above *Bref*.

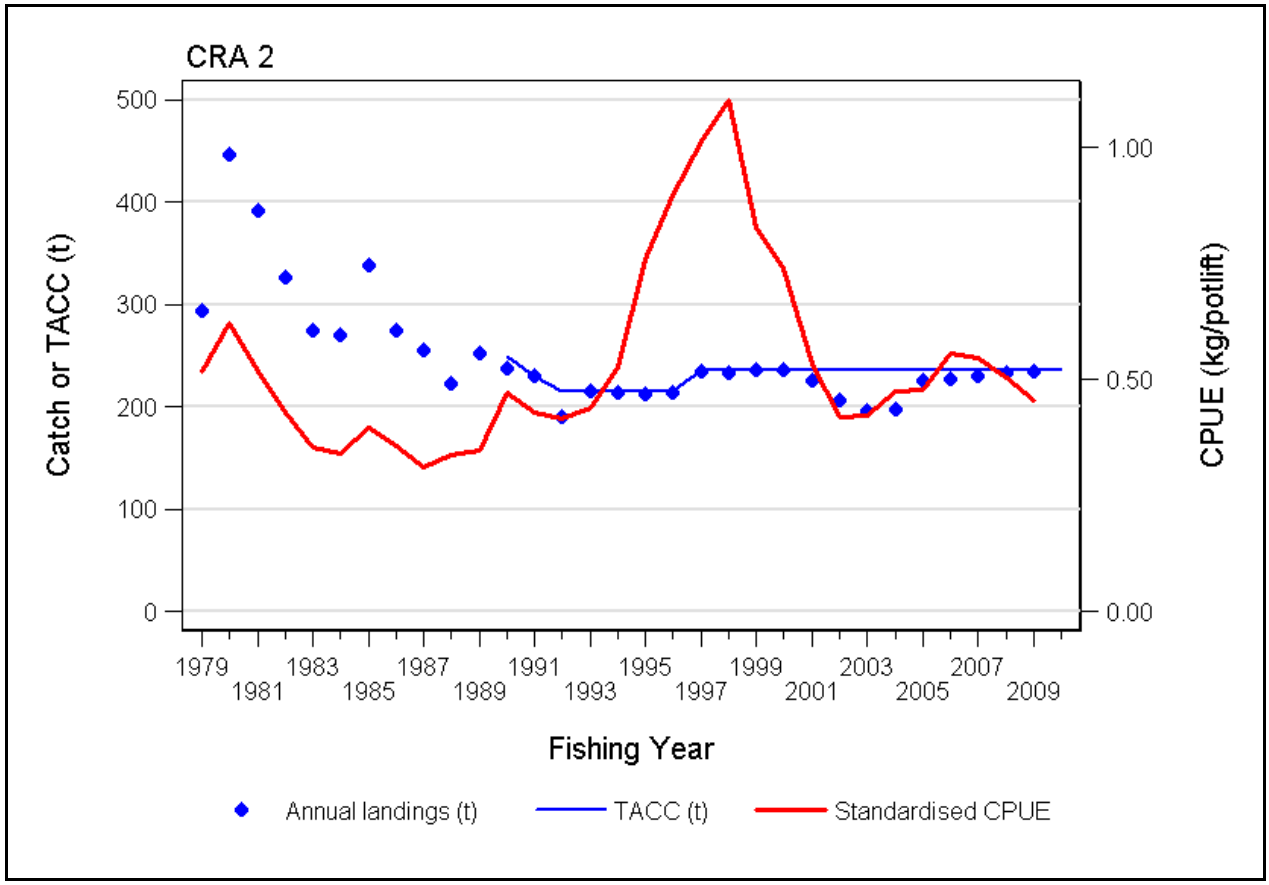
181. The 131.062 tonnes CRA 1 TACC is distributed amongst 25 quota share owners. Thirteen permit holders reported CRA 1 catches in 2009/10. The estimated landed value of the commercial catch was $7.2 million (based on average port price paid to fishermen), making rock lobster an important contributor to the local and regional economy.

182. Amateur catch of rock lobster is estimated at 47 tonnes (MFish 1996). Diving using UBA is the predominant method used by amateur fishermen and women, although hand gathering, ring potting, and potting from vessels are also used.

183. Rock lobsters have cultural significance to local Maori and a large Maori population in the Northland region ensures that rock lobster retains significant customary value. No reliable estimates are available for customary catch. The progressive implementation of reporting procedures within the North Island Customary Regulations might assist in future evaluations of customary harvest for the CRA 1 fishery.

184. CRA 1 stock status is assessed using commercial catch and effort and quota monitoring report data. Tag, release and recapture projects have been updated 1996. In addition, the CRA 1 commercial stakeholders enable intensive observer catch sampling sequences for the fishery. The CRA 2009-01 research contract provides for catch sampling sequences to be done annually until 2012.

13. CRA 2



185. The CRA 2 fishery extends from Waipu through the Hauraki Gulf and Bay of Plenty to East Cape. The current 452.6 tonnes TAC for the fishery was set in 1997. The TAC is comprised of 140 tonnes for amateur catch, 16.5 tonnes for customary harvest and 60 tonnes for illegal removals. The current TACC is 236.1 tonnes.

186. The last stock assessment for CRA 2 was made in 2002 (Starr *et al.* 2003), with the version of the Bayesian length-based rock lobster model used at that time. This was fitted to historical catch per day, daily CPUE, size data from market sampling, voluntary logbooks and observer catch sampling, and tag-recapture data. Changes in MLS and selectivity caused by escape gap regulations were taken into account.

187. The assessment used performance indicators based on biomass levels for the ten years 1979–88, a period during which biomass was relatively stable.

188. The assessment suggested that biomass decreased to a low point in 1977, increased to 1980, declined slowly through 1988, increased strongly to a peak in 1998 and then declined again to 2002. The assessment suggested that biomass in 2002 was 150% of *Bref* (5% to 95% limits 130 to 170%) and that biomass projected over five years would stay roughly the same (but with high uncertainty, ranging from 35% decrease to 60% increase).

189. Since 1997 the TACC has remained the same, and since 1993 the TACC has been more than 85% caught, except for 2002-04, averaging 85%. As predicted by the stock assessment, CRA 2 CPUE showed little change for three years after 2002, then increased by about 20% to 2006 but has since declined. Combined with the previous assessment, this suggests a stock still above *Bref*.

190. The 236.1 tonnes TACC is distributed amongst 43 quota share owners. In 2009/10 there were 32 vessels reporting commercial catches. The main operating period for commercial vessels generally extends from June to January. The estimated landed value of the CRA 2 catch is $13.1 million (based on average port price paid to fishermen) and the industry sustains a number of processing and export companies in Tauranga, Whitianga, and Auckland.

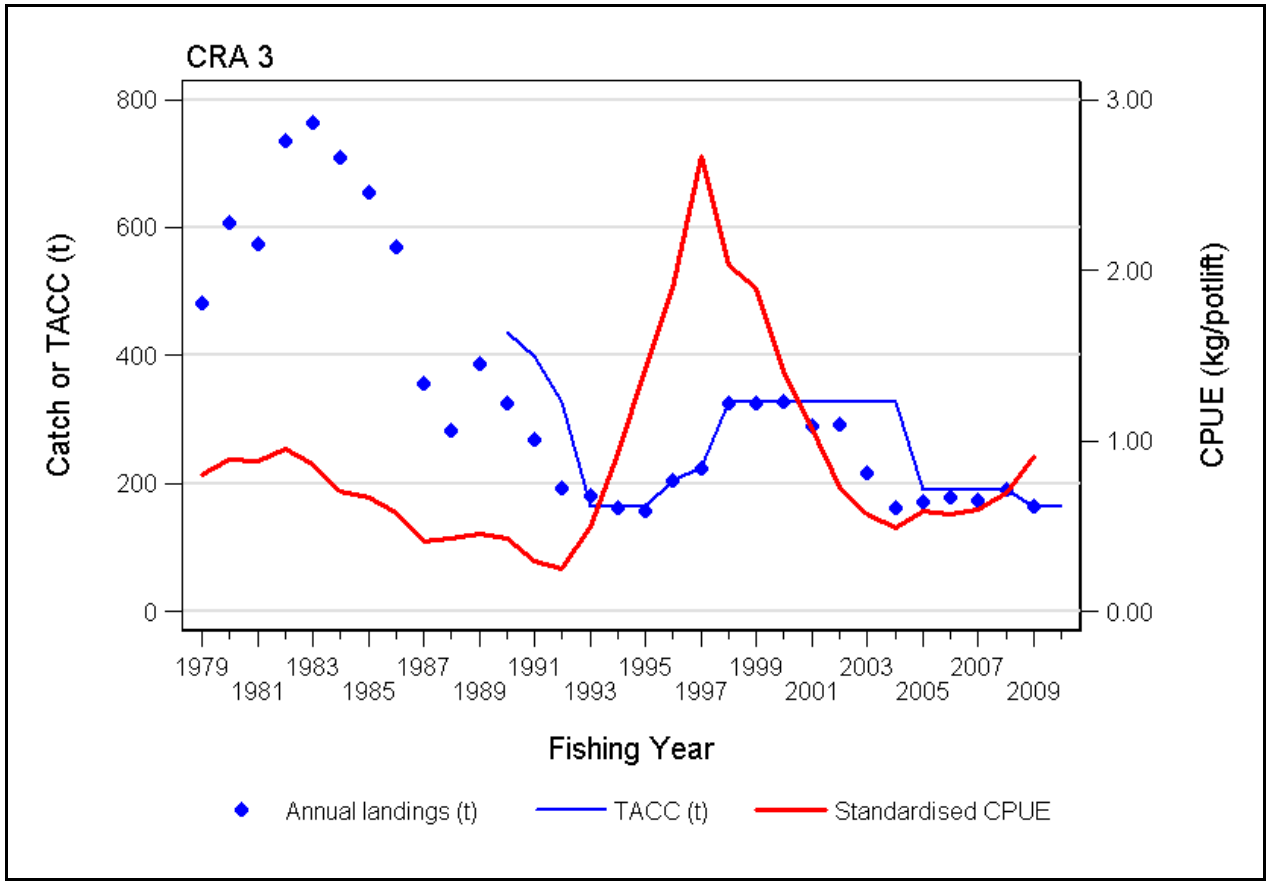
191. Amateur catch in this fishery is estimated at 140 tonnes (MFish 1996). Potting and diving are the preferred methods, and there is a large recreational charter vessel industry catering to the sector.

192. Customary catch is conservatively estimated at 16.5 tonnes. Anecdotal evidence in recent seasons suggests that the actual harvest may have been much greater. Rock lobsters have cultural significance to local Maori and a large Maori population in the Bay of Plenty region ensures that rock lobster retains significant customary value.

193. The CRA 2 Rock Lobster Company Ltd is the representative commercial stakeholder group for this region. The Company has made significant investments in rock lobster research since its formation in 1995, including a comprehensive vessel logbook programme, tag and release projects, and sequences of intensive catch sampling to MFish standards and specifications. These data continue to be collected. The CRA 2 Company has invested in and implemented an Electronic Logbook programme intended to collect fine scale commercial catch and effort data.

194. Stock monitoring activities for the 2010/11 season included the continuation of logbook coverage, intensive catch sampling sequences within season, and tag recapture reporting. Similar coverage is contracted forward to 2012.

14. CRA 3



195. The CRA 3 fishery extends from East Cape south to the Wairoa River.

196. The most recent stock assessment for CRA 3 was made in 2008 (Starr *et al*. 2009; Breen et al 2009a). This used the multi-stock length-based model (MSLM) of Haist et al. (2009), but with modifications that were necessary to address a change in growth rate that was apparent between older and newer tag-recapture data. The model was used as a single-stock model for this assessment.

197. The model was fitted to tag-recapture data from 1975–1981 and from 1995–2006, standardised CPUE from 1979–2007, historical catch rate data from 1963–1973 and length frequency data from commercial catches (log book and catch sampling data) from 1989 to 2007.

198. Indicators were based on AW vulnerable biomass and included current biomass, *B2008* and projected biomass, *B2012*. A *Bmsy* indicator was calculated with deterministic projections for 50 years that used mean recruitments from 1979-2004. There were some problems: *Bmsy* calculations were very sensitive to mean recruitment, and assumptions about non-commercial catches were necessary. In addition, the Bayesian uncertainty part of the assessment showed problems.

199. The assessment showed that biomass declined until 1989, increased strongly in the 1990s followed by a sharp decrease. The assessment suggested that 2008 biomass was 50% (5% to 95% range 40 to 65%) of *Bmsy*. At the then-current TAC, biomass was projected to decline by 25%. As a result, the TAC was reduced to a level which gave a 50% probability of increase over 5 years.

200. The assessment was not updated in 2009, but the model was updated with the most recent CPUE data in connection with development of a CRA 3 management procedure (Breen *et al*. 2009b). For this work, the RLFAWG agreed to discard the *Bmsy* indicator and adopt a target indicator *Bref* based on autumn-winter vulnerable biomass in 1974–79, adjusted for changes in MLS, selectivity and the change in growth rate. CPUE has increased over the past three seasons.

201. For the 2010/11 season, stock monitoring in CRA 3 comprises 28 sample days across three statistical areas (909, 910, and 911) and 1000 tags deployed in 909.

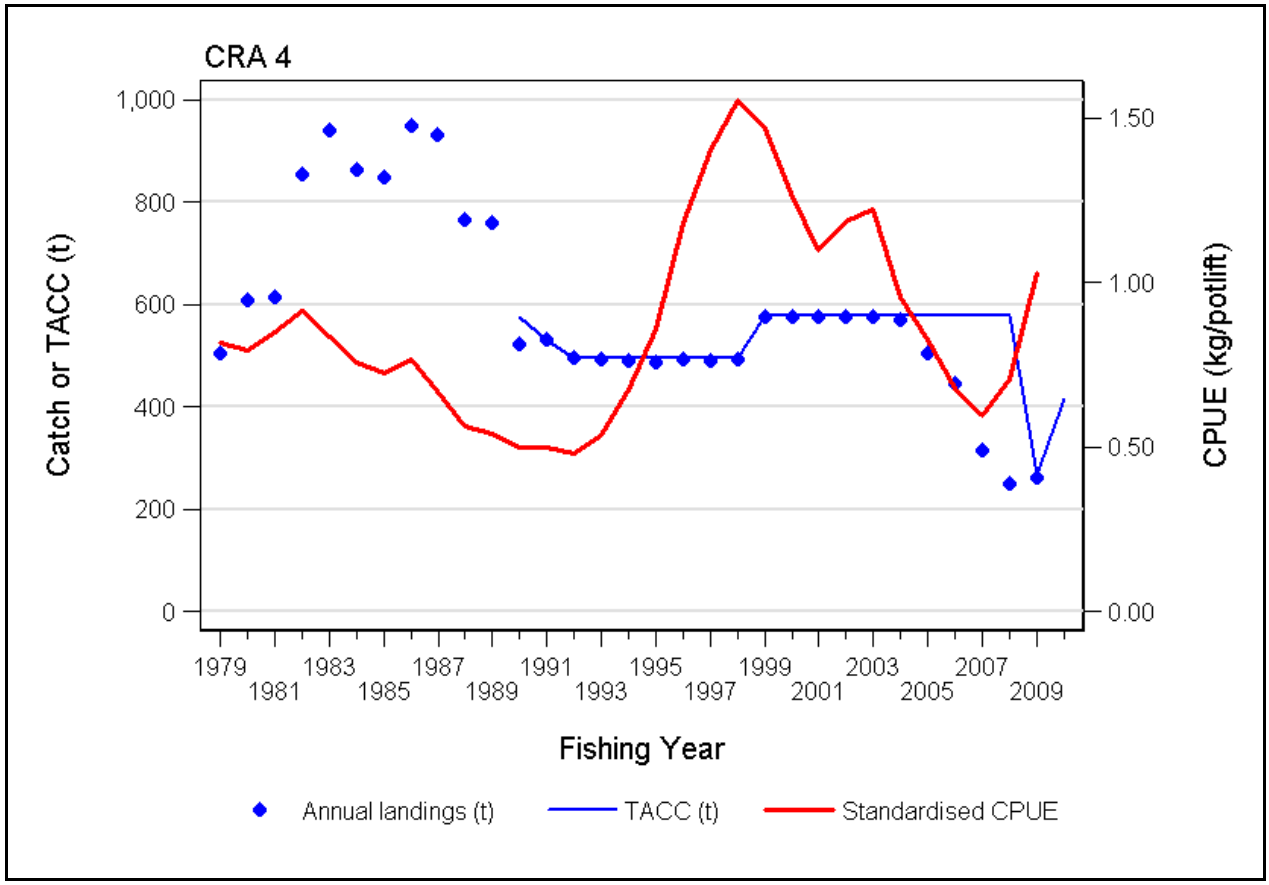
202. The current 293 tonnes TAC is comprised of a 20 tonnes allowance for amateur catch, a 20 tonnes allowance for customary harvest, an 89 tonnes allowance for illegal removals and a TACC of 164 tonnes.

203. The TACC is distributed amongst 43 quota share owners. In 2009/10 CRA 3 landings were reported by 24 commercial vessels. There is significant Iwi involvement in quota share ownership and fishing. The commercial harvest has an approximate landed value of $9.1 million (based on average port price paid to fishermen). There are two processing plants in Gisborne, and product is also shipped to Wellington, Tauranga and Auckland for processing and export.

204. Amateur catch is currently unknown but was estimated at 14 tonnes (RLFAWG 2001), although an allowance of 20 tonnes was again made in the 2010 TAC decision. Potting and hand gathering are the preferred amateur fishing methods.

205. Rock lobsters have great cultural significance to local Maori and there is a very high level of customary harvest activity. Customary removals are uncertain although an allowance of 20 tonnes was made in the 2010 TAC decision.

15. CRA 4



206. The CRA 4 fishery extends from the Wairoa River on the east coast, southwards along the Hawkes Bay, Wairarapa and Wellington coasts, through Cook Strait and north to the Manawatu River.

207. The most recent stock assessment for CRA 4 was in 2005 (Breen *et al*. 2006) with the version of the Bayesian length-based rock lobster model used at that time. This was fitted to historical catch per day, daily CPUE, size data from market sampling, voluntary logbooks and observer catch sampling, and tag-recapture data. Changes in MLS and selectivity caused by escape gap regulations were taken into account.

208. The assessment used performance indicators based on autumn-winter vulnerable biomass. *Bref* was the mean of 1979–88, a period when biomass was relatively stable. The assessment suggested that biomass decreased to stable but low levels throughout the 1980s and early 1990s, then increased strongly to a peak in 1998 and declined again. The assessment suggested that biomass in 2006 was 180% of *Bref* (5% to 95% limits 150 to 210%) and that biomass was likely to decline slightly in the next three years.

209. In the event, CPUE declined strongly from 2003 to 2007, and catch was less than the TAC from 2005. Industry-initiated catch reductions through ACE shelving were made in 2006 and 2007, based on a management procedure (Breen & Kim 2006), and this management

procedure was adopted by the Minister of Fisheries in 2008. This initiative appears to have been successful, because autumn-winter CPUE has increased in the past two years. The current position of the stock relative to *Bref* is unknown.

210. The CRA 4 Management Procedure was used to guide the decision to adjust the TAC from 771 tonnes to 461 tonnes as from April 2009. The reduction was made by adjusting the TACC from 577 tonnes down to 266 tonnes – a level commensurate with the voluntary commercial catch limit then in place.

211. The CRA 4 Management Procedure was again used to guide the 2010 TACC decision. The procedure invoked a 466 tonnes commercial catch limit but the majority of industry participants and the Minister agreed a proposal for a lesser increase. The 2010/11 TACC was set at 415.6 tonnes with no changes made to non-commercial allowances.

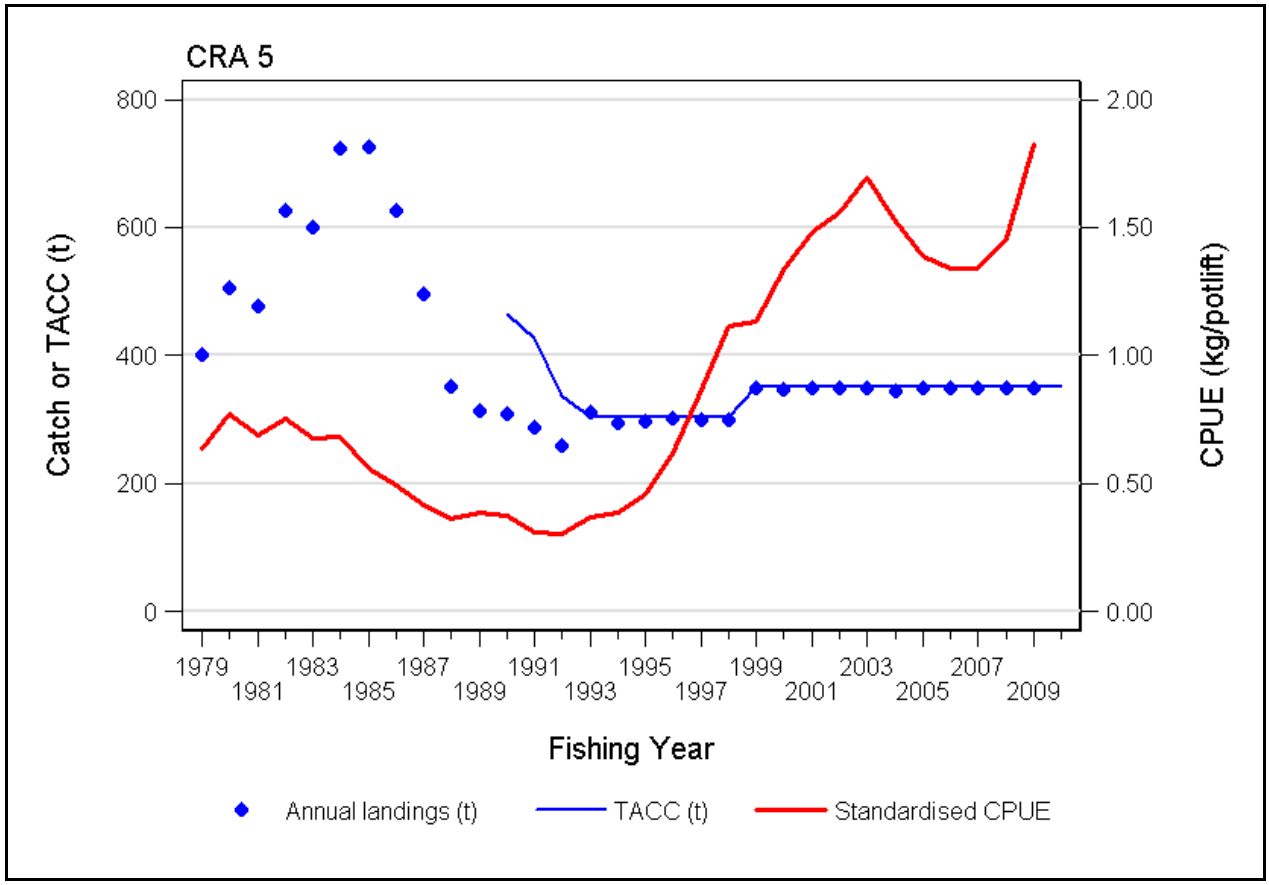
212. The current 415.6 tonnes TACC is distributed amongst 85 quota share owners. The CRA 4 commercial fleet comprised 43 vessels in 2010. The majority of vessels in the fleet operate from coastal bases in isolated rural areas on the Hawkes Bay and Wairarapa coastline. The CRA 4 commercial catch supports several processing and export operations in Napier and Wellington, and Auckland. The value of the 415 tonnes commercial catch is estimated at $22.9 million in 2010.

213. The amateur catch is estimated at 73 tonnes (MFish 1996). Potting and hand gathering are the preferred methods for amateur fishers in this area. As in most CRA areas, the majority of amateur catch is taken in the summer months. The region sustains a recreational fishing and dive charter industry during those months.

214. Aggregate customary harvest estimates for CRA 4 are not available, but the reporting requirements associated with the implementation of the North Island Customary Regulations should enable more informed decision making in future.

215. A comprehensive stock monitoring programme has been established in the CRA 4 fishery. There is a long time series of intensive catch sampling data from Napier, Castlepoint, Cape Palliser, and the Wellington south coast. This series was extended in the current season with a total of 32 sample days to be completed for the period May 2010 to February 2011 and further stock monitoring activities are confirmed through to 2012. The CRA 4 tag and release programme is for 2000 tags to be deployed in 2010. Puerulus settlement is also monitored at several sites within CRA 4.

16. CRA 5



216. The CRA 5 fishery extends from the western side of the Marlborough Sounds across to Cape Jackson and then southwards to Banks Peninsula. There are three distinct regions of commercial fishing — Picton/Port Underwood, Ward-Kaikoura-Motunau, and Banks Peninsula, although a small number of commercial vessels work the area from Nelson through to D'Urville Island. The bulk of the commercial catch is taken from the area bounded by Tory Channel in the north and Motunau in the south.

217. In 2010 a single-stock version of the multi-stock length-based model (MSLM) (Haist et al. 2009) was fitted to two series of CRA 5 catch rate indices from different periods, and to size frequency, puerulus settlement and tagging data. This model was fitted to historical catch per day, daily CPUE, size data from market sampling, voluntary logbooks and observer catch sampling, tag-recapture data and a pre-recruit index from voluntary logbook data. Changes in MLS and selectivity caused by escape gap regulations were taken into account.

218. The assessment used performance indicators based on autumn-winter vulnerable biomass. *Bref* was the mean of 1979–88, a period when biomass was relatively stable. In the base case and for all trials, the median value for Bref was larger than the median for Bmsy and the probability of Bref being greater than Bmsy was al least 57%. In the base case and for all trials, current and projected biomass levels were larger than Bref and Bmsy reference levels by substantial factors for both catch projection scenarios.

219. From 2003 to 2008, CPUE declined by 15%, but increased in 2010 to above the 2003 value. Combined with stock assessment, this suggests a stock well above *Bref*.

220. The TAC has remained the same since 1999, and TACC has been fully caught since 1993. In the 1993 decision 40 tonnes was allowed for amateur catch and 40 tonnes for customary catch. The TACC was increased from 303.7 tonnes to 350 tonnes. The allowance for illegal unreported removals is 37 tonnes.

221. Amateur catch was estimated at 35 tonnes (MFish 1996). However, for the 2010 stock assessment the RLFAWG agreed to assume that the recreational surveys in 1994 and 1996 were accurate and that recreational catches increase as abundance changes (reflected in spring/summer CPUE). Under these assumptions the current recreational catch is more than 100 tonnes. The preferred methods for amateur fishing are potting and diving with UBA. Recreational rock lobster fishing and the dive charter industry are both growing in the region. Dive clubs in the region have previously reported tag recapture.

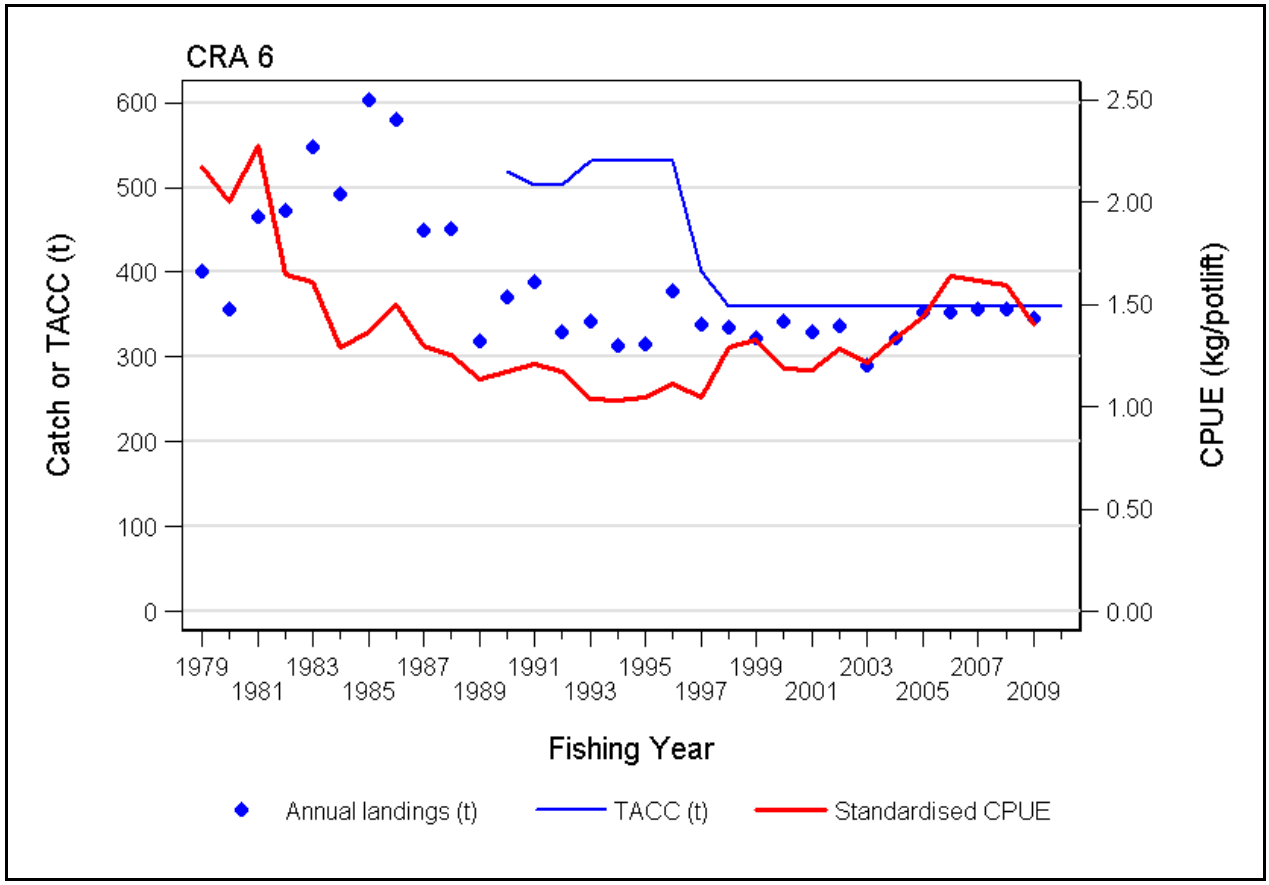
222. Customary catches reported to MFish were about 1 tonne for the most recent year. For the 2010 stock assessment the RLFAWG agreed to assume that customary catches have been 10 tonnes in each season.

223. There are 41 quota share owners in CRA 5. The fleet comprised 25 vessels reporting catch in 2010. Many commercial vessels work off beaches between Port Underwood and Motunau. The landed value of the commercial catch is estimated at $19.3 million in 2010 (based on average port price paid to fishermen), and the fishery supports processing and export facilities in Ward, Kaikoura, Wellington and Christchurch

224. The CRA 5 industry members, through membership of their commercial stakeholder group CRAMAC 5, have encouraged and facilitated an ongoing dialogue with amateur fishing and dive clubs and with Iwi groups in the region. The responses to the process have been extremely encouraging in terms of future co-operative research and management initiatives.

225. CRA 5 has an intensive stock-monitoring regime in place. Intensive catch sampling and tag and release projects have been done as sub-contracted research services, and CRAMAC 5 operates an extensive Vessel Logbook programme that provides data to the stock assessment process. A short observer catch sampling sequence was done in 2010 in order to benchmark logbook data. Similar levels of stock monitoring are confirmed through to 2012.

17. CRA 6



226. The region designated as CRA 6 is geographically very large, being all waters within a 200 nautical mile radius of the Chatham Islands and Bounty Islands, but the area being fished is restricted to a relatively narrow coastal margin adjacent to the Chatham Islands coastline.

227. Previous RLFAWG reports have noted that the CRA 6 data are consistent with a stock model in which the biomass being fished is much smaller than the biomass of the contributing stock. The abundance of the standing stock in CRA 6 is possibly more dependent on immigration of larger lobsters into the area than it is on recruitment and growth.

228. The most recent formal stock assessment was in 1996 (Breen & Kendrick 1998). This used alternative methods, including a depletion model and a constant-production model. Both models assumed a constant level of annual productivity is independent of the stock size and thus outside the realm of *Bmsy* approaches.

229. In 2009, in association with management procedure development for CRA 6, both surplus-production and constant-production models were used and fitted to catch and CPUE data through 2008-09 (Breen submitted). The SP model implied that the stock is about half *Bmsy* and that yields could be doubled by rebuilding the stock to *Bmsy*. However, the constant-production model estimated production to be 376 tonnes (5% to 95% range 368 to 384 tonnes), and suggested that mean catch could be increased slightly from its current level.

The catch data form a "one-way trip" and it is not possible to determine which model is better. Size structure has remained nearly the same over a long period, at least until very recently.

230. The TAC for CRA 6 has remained unchanged since 1998, but was less than 95% caught from 1990-2004 (except for 2000, on 95%). Since 2005 it has been 98% caught. CPUE has increased steadily by 25% since 1999.

231. The relation between the current stock size and a target level is unknown.

232. For the 1998/99 fishing year a TAC of 370 tonnes was set. A total of 6 tonnes was set aside for amateur catch and 4 tonnes was provided for customary catch. The TACC was reduced from 400 tonnes to 360 tonnes in response to MFish concerns over declining landings and declining CPUE. The TAC and TACC remain unchanged since April 1998 and CPUE showed incremental improvement to 2006/07 and has since marginally declined.

233. CRA 6 is unique in that unlike all other CRA management areas, two harvest methods are allowed for commercial fishing. The bulk of the TACC is landed from vessels using pots, but there are limited numbers of method concessions issued for the fishery and divers take quantities of lobsters in the summer months.

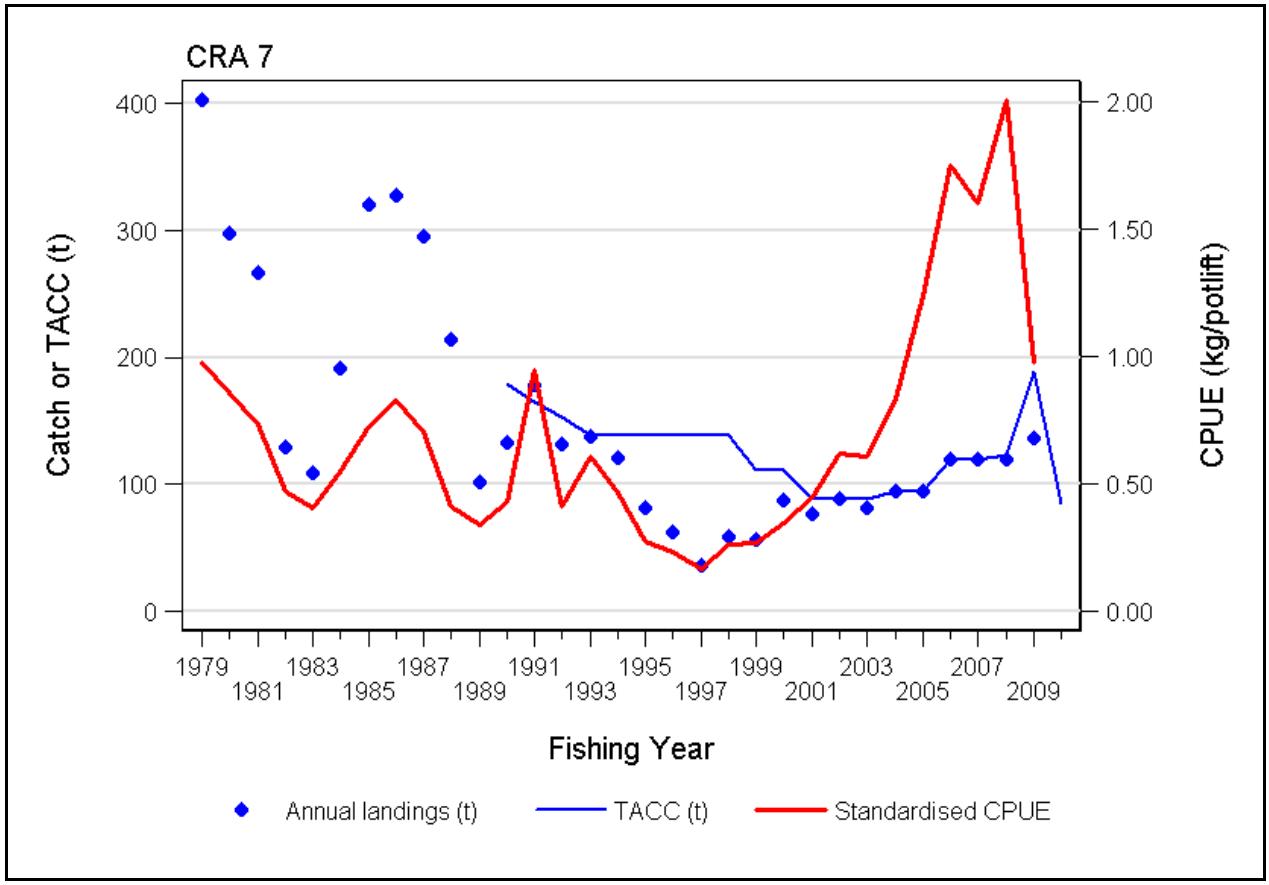
234. There are 50 CRA 6 quota share owners. Mainland New Zealand interests own the majority of quota. There are currently 35 vessels reporting CRA 6 landings and the number of divers is unknown although only 11 of the original method exemptions issued to qualifying persons between 1990 and 1993 were current during 2005-06. Additional divers operate under the authority of permits in the name of the consent holders.

235. The landed value of the commercial catch in 2010/11 is approximately $19.4 million (based on average port price paid to fishermen). The fishery supplies processing and export facilities on the Chatham Islands and in Auckland, Wellington, and Christchurch.

236. The CRA 6 Industry Association established a Fishermen's Office at Waitangi in May 2000 and the NZ RLIC contracted an administrative officer trained by FishServe to co-ordinate the distribution and collation of Catch Effort Landing Returns and Monthly Harvest Reports for delivery to FishServe and to provide a range of additional administrative services to the Chatham Islands seafood industry.

237. There is no major research programme currently underway for the fishery because all previous research initiatives — intensive catch sampling, tagging, and juvenile abundance surveys — have delivered similar results. There are also high costs associated with research co-ordinated from the mainland. However, the CRA 6 Industry Association is managing a Vessel Logbook programme, such as used in CRA 2, CRA 5, and CRA 8, to collect size frequency and abundance information.

18. CRA 7



238. The CRA 7 fishery extends from the Waitaki River south along the Otago coastline to Long Point.

239. The CRA 7 fishery is one of the two fisheries that comprise the NSS sub-stock that until 2007 was used for assessment purposes. CRA 8 is the other. The TAC and allowances within the TAC have been set for CRA 7 by the operation of a management procedure which was implemented in 2008. A revised management procedure was recommended to the Minister in December 2010 to guide TAC decisions from 2011.

240. The most recent stock assessment was in 2006 (Breen *et al*. 2006; Haist *et al*. 2009), using the then-new Bayesian multi-stock length-based model (MSLM). This was fitted to CRA 7 and CRA 8 simultaneously, and estimated movements between CRA 7 and CRA 8. The model was fitted to tag-recapture data, standardised CPUE from 1979-2006, historical catch rate data from 1963-73 and length frequency data from voluntary logbooks and observer catch sampling. Changes in MLS and selectivity caused by escape gap regulations were taken into account.

241. The assessment used performance indicators based on autumn-winter vulnerable biomass. *Bref* was the mean of 1979–81, a period when the fishery showed high productivity and the

biomass level was demonstrably safe, because it subsequently declined to lower levels and then recovered.

242. The assessment suggested that biomass declined steadily to 1989, then increased slightly to 1993 and declined again to 1998, when it began to increase. The assessment suggested that biomass in 2006 was 170% of *Bref* (5% to 95% limits 100 to 220%) and that biomass was likely to increase by 8% over the next three years (ranging from a 9% decrease to a 28% increase).

243. From 1996 to the present, the TAC has been controlled by management procedures. From 1990 through 2003, on average only 74% of the TACC was caught. The TACC was fully caught from 2004 to 2008. CRA 7 CPUE increased strongly by several fold from 1999-2008, but the 2009 offset-year CPUE showed a decrease, which triggered a TAC/TACC decrease from April 2010. The operation of the revised management procedure in 2010 invokes no change to the 2011/12 TAC.

244. The CRA 7 TAC is currently 104.5 tonnes. A total of 10 tonnes is provided for customary catch, 5 tonnes is set aside for amateur catch and 5 tonnes for illegal unreported removals. The TACC is set at 84.5 tonnes.

245. The CRA 7 commercial season runs from 1st June to 19th November inclusive and the MLS is a tail length of 127 mm for both male and female lobsters. The fishery is open to amateur fishing all year with a MLS regime of 54 mm TW for males and 60 mm TW for females.

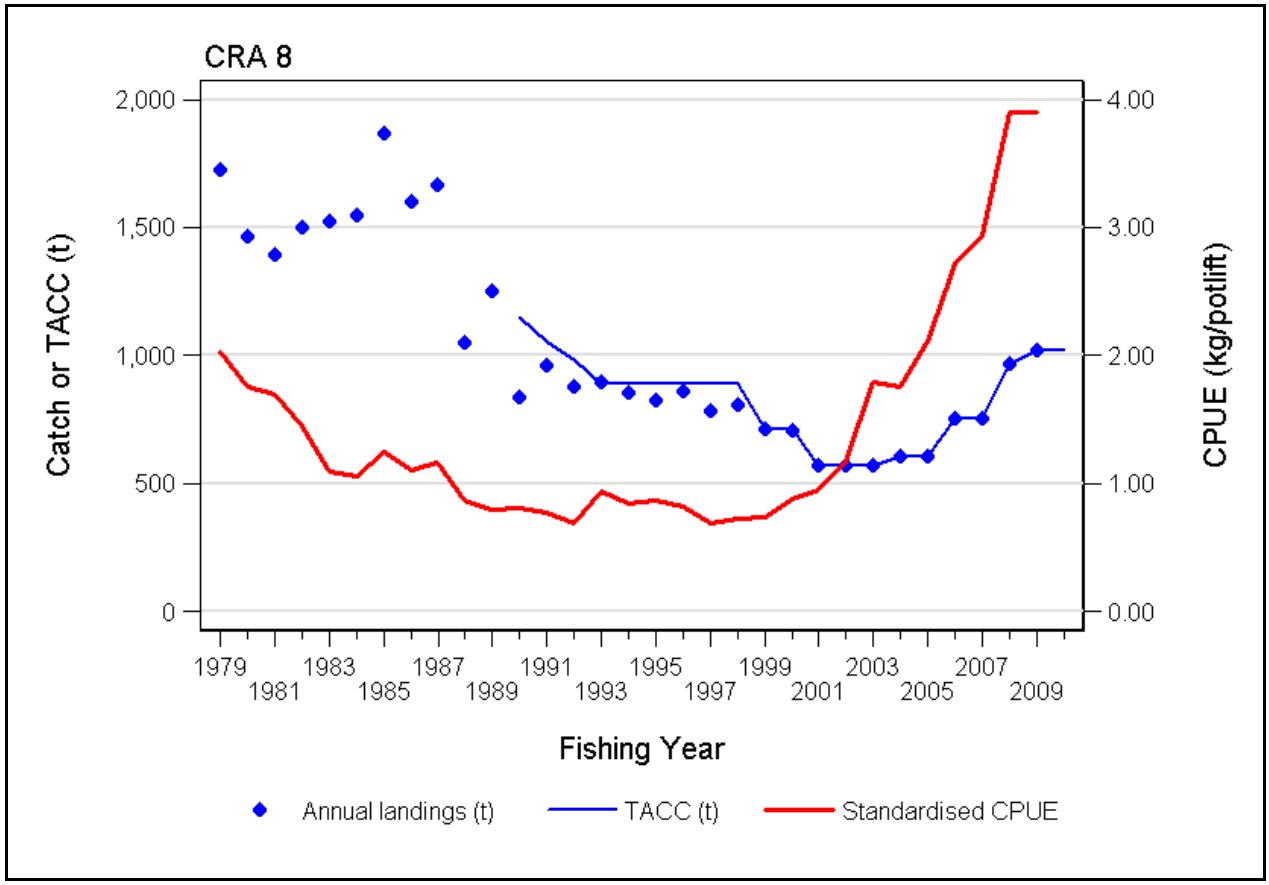
246. The CRA 7 fishery is unique in that there is a 'buffer zone', closed to commercial rock lobster fishing which was incorporated into a regional harvest initiative agreed by amateur and commercial users in 1993 in response to concerns over sustainability of the stock.

247. There are 33 CRA 7 quota share owners. In 2009/10 16 commercial vessels reported CRA 7 landings. The landed value of the 2010 season catch is estimated at $4.2 million (based on average port price paid to fishermen). The CRA 7 catch is processed and exported, or sold to the domestic market, by several Dunedin and Christchurch fishing companies.

248. The most recent estimates of recreational rock lobster catches from CRA 7 are less than 5 tonnes. There are no recent estimates of customary removals but for assessment purposes removals are estimated at 1 tonne for customary and 1 tonne for illegal unreported.

249. Stock monitoring coverage in CRA 7 comprises a scheduled sequence of 18 observer sampling days across all Statistical Areas in every season and during 2007 a rock lobster tag and release programme was updated with 3000 tags deployed between June and September.

19. CRA 8



250. The CRA 8 fishery is the largest mainland fishery geographically. The region extends from Long Point south to Stewart Island and the Snares, the islands and coastline of Foveaux Strait, and then northwards along the Fiordland coastline to Bruce Bay.

251. The most recent stock assessment was in 2006 (Breen *et al*. 2006; Haist *et al*. 2009), using the then-new Bayesian multi-stock length-based model (MSLM). This was fitted to CRA 7 and CRA 8 simultaneously, and estimated movements between CRA 7 and CRA 8. The model was fitted to tag-recapture data, standardised CPUE from 1979-2006, historical catch rate data from 1963-73 and length frequency data from voluntary logbooks and observer catch sampling. Changes in MLS and selectivity caused by escape gap regulations were taken into account.

252. The assessment used performance indicators based on autumn-winter vulnerable biomass. *Bref* was the mean of 1979–81, a period when the fishery showed high productivity and the biomass level was demonstrably safe, because it subsequently declined to lower levels and then recovered.

253. The assessment suggested that biomass declined steadily to 1990, then increased slightly to 1994 and declined again to 2000, when it began to increase. The assessment suggested that

biomass in 2003 was 121% of *Bref* (5% to 95% limits 97 to 150%) and that biomass was likely to increase by 50% over the next three years (35 to 80%).

254. From 1996 to the present, the TAC has been controlled by management procedures. The TACC has been fully caught from 1998 onwards. CRA 8 CPUE increased strongly nearly four-fold from 1999-2008, and the most recent offset-year CPUE shows a decrease which has invoked a TAC reduction to 1053 tonnes.

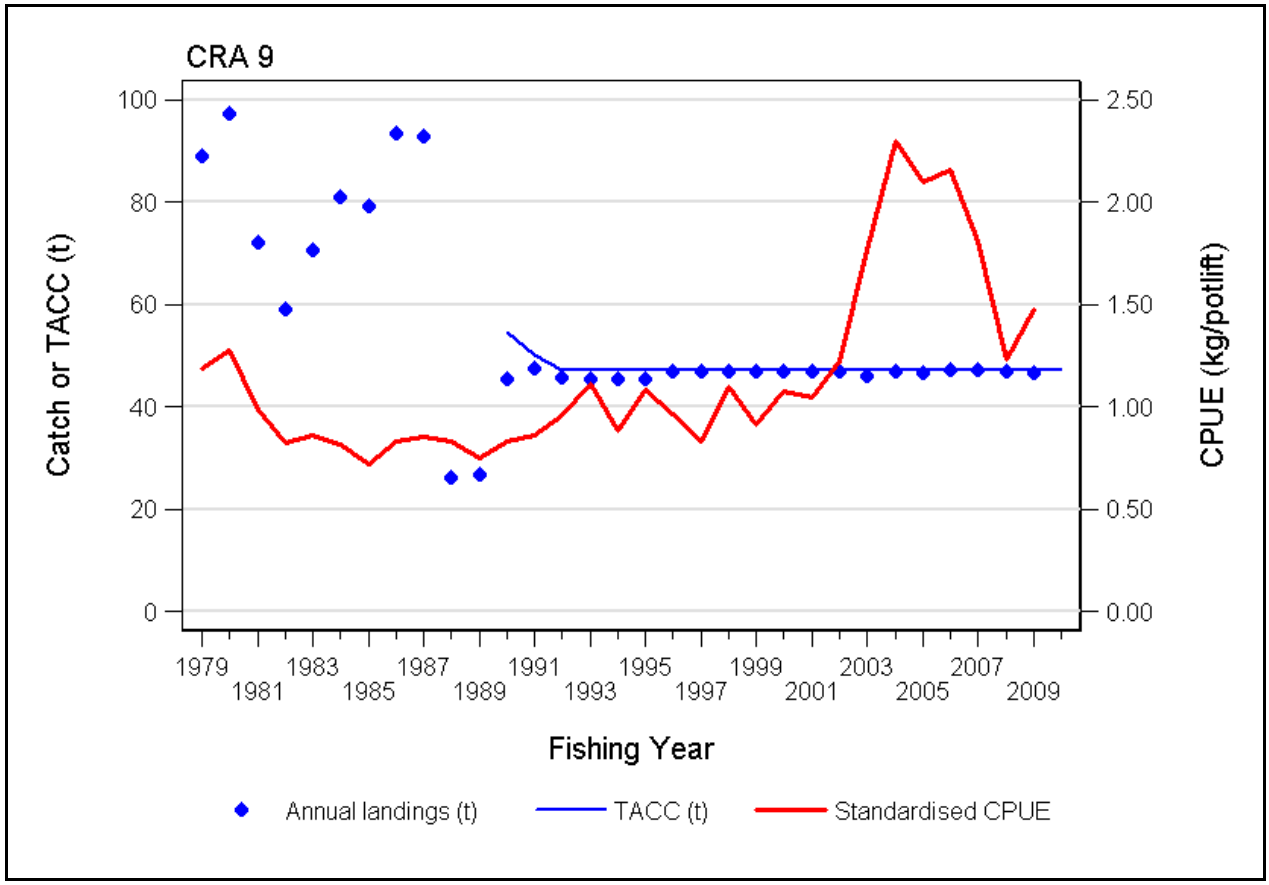
255. A TAC of 1110 tonnes was set for the 2009/10 fishing year. A total of 29 tonnes was set aside for amateur catch and 30 tonnes was provided for customary catch. The TACC was set at 1019 tonnes. The TAC adjustment was undertaken in response to the triggering of the harvest control rule in the CRA 8 Management Procedure. The TACC will reduce to 962 tonnes for 2011/12.

256. Amateur catch is estimated at 16 tonnes (MFish 1996). The preferred methods for amateur fishing are potting and diving with UBA. There are no reliable estimates of customary catches.

257. There are 117 CRA 8 quota share owners. In 2009/10 there were 62 commercial vessels reporting CRA 8 landings. The CRA 8 fleet operates in the most remote coastal areas of South Westland and Fiordland. The value of the landed catch is estimated to be $56.4 million (based on average port price paid to fishermen). The industry supplies processing and export operations in Te Anau, Riverton, Stewart Island, Invercargill, Bluff, Christchurch, and Wellington.

258. The CRA 8 Management Committee Inc. is the commercial stakeholder organisation for the fishery. The committee employs a Chief Executive. The organisation has developed and implemented codes of practice in relation to use and disposal of fishing gear and refuse, and as a founding member of the Guardians of Fiordland Fisheries, has contributed to an extensive code of practice for the waters adjacent to the World Heritage area.

20. CRA 9



259. The CRA 9 fishery is geographically large but has the smallest TACC of any region (with the exception of CRA 10). The fishery extends from north of Bruce Bay to the Kaipara Harbour but commercial lobster fishing is constrained to the north-west coast of the South Island and the area between Patea and Kawhia, in particular the Taranaki coastline.

260. No formal stock assessment has been done for CRA 9. No TAC has been set for this fishery and the 47 tonnes TACC set in 1990 has remained unchanged and has been fully caught since 1992. CPUE increased by 220% from 1999 to 2006, declined by 10% and has since increased. The relation between current stock size and target biomass is unknown.

261. There are no estimates of amateur or customary catch for the CRA 9 fishery.

262. There are twenty three CRA 9 quota share owners. In the 2009/10 season only six commercial vessels reported CRA 9 landings. The estimated value of the landed catch is $2.6 million (based on average port price paid to fishermen). The industry supplies processing and export operations in Marlborough, Nelson, New Plymouth, Wellington, and Auckland.

263. No stock assessment has been made for the CRA 9 fishery. CPUE was consistent over many years and has shown a significant increase since 2001/02 then stabilised to 2006 after which

it declined sharply until 2008 and has since increased. The TACC has constrained commercial landings in every season from 1990, and CPUE suggests a stable or increasing stock. A preliminary evaluation of a CRA 9 management procedure was reported to the FAWG in 2010. Such a procedure could be used in future to guide decisions on setting a TAC for CRA 9.

21. PACKHORSE ROCK LOBSTER – PHC

264. The packhorse rock lobster management area extends to all of New Zealand.

265. The TACC for this fishery was set at 30 tonnes in 1990, but was increased to 40 tonnes in 1992 as a result of appeals. Historically the fishery has been primarily an incidental catch for many commercial rock lobster fishermen in the Northland/Auckland and Bay of Plenty regions. However several fishermen did successfully target the species prior to 1990 and dependent on environmental conditions others have attempted to do so in several seasons since.

266. Because of different biology and behaviour of this species, the MLS is set at 216 mm tail length. Prohibitions on the taking of berried female lobsters apply. In addition, a large area of water to the north-east of North Cape was closed to commercial rock lobster fishing on a year-round basis in 1977 in an apparent effort to protect what was then thought to be a large concentration of sub-legal PHC rock lobsters.

267. Commercial catches have fluctuated since 1990, reaching a peak of 36.3 tonnes in the most recent season. The recent commercial landings are reported in Table 9:

Season	PHC Commercial Landings (tonnes)
1999-00	12.6
2000-01	9.8
2001-02	7.8
2002-03	8.6
2003-04	16.4
2004-05	20.8
2005-06	25.0
2006-07	25.4
2007-08	34.1
2008-09	36.3
2009-10	40.3

Table 9: *Packhorse Lobster Commercial Landings*

268. It was thought that the previous shortfalls of catch against quota reflected the low levels of target effort being directed at the fishery which is known to have variations in abundance possibly determined by weather and sea temperatures.

269. In 2003/04 an estimated 24 commercial vessels reported PHC catch. Less than five are currently known to be target fishing the species, all of these are operating in either CRA 1 or CRA 2. The value of the landed catch is estimated to be in excess of $2 million.

270. There are no estimates of amateur catches for the species but divers using UBA are known to target PHC in Northland and the Bay of Plenty as "trophy" fish. There are no estimates of customary harvest.

References:

Breen, P.A., V. Haist & P.J. Starr. 2006. - CRA2006 Objective 4 Stock assessment of red rock lobsters (*Jasus edwardsii*) in CRA 7 and CRA 8 in 2006, using a new multi-stock length-based model (MSLM). Final Research Report to Ministry of Fisheries, 19 December 2006. 116 pp.

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Starr, P.J., N. Bentley, P.A. Breen & S.W. Kim. 2003. Assessment of red rock lobsters (*Jasus edwardsii*) in CRA 1 and CRA 2 in 2002. *New Zealand Fisheries Assessment Report 2003/35*. 112 pp.

Starr, P.J.; Breen, P.A.; Kendrick, T.H.; Haist, V. (2009). Model and data used for the 2008 stock assessment of rock lobsters (*Jasus edwardsii*) in CRA 3. *New Zealand Fisheries Assessment Report 2009*/22. 62 pp.

22. SUMMARY OF ROCK LOBSTER FISHERIES REGULATIONS

271. The following is a summary of the important regulations governing the rock lobster fishery. This is not exhaustive and concentrates on the catching sector rather than on processing or related activities.

272. Differential minimum legal sizes (MLS) apply to *J. edwardsii*.

a) The general MLS is 54 mm tail width (TW) for male rock lobsters and 60 mm TW for females. This is the standard measure for amateur fishing in all areas.

b) In the Otago area (between the Waitaki River and Nugget Point), the MLS for commercial fishing is 127 mm tail length (TL).

c) In Southland the MLS for commercial fishing is 54 mm TW for males and 57 mm TW for females.

d) In the Gisborne-East Coast region the commercial fishing MLS for males is 52mm TW for the months of June, July and August only and reverts to 54 mm TW for the remainder of the fishing year. The MLS for female rock lobsters is 60 mm TW year around.

273. For each of those regions the MLS differentials are linked to the TACCs based on yield estimates that have been determined by stock assessments.

274. The minimum legal size for *S. verreauxi* (Packhorse) is 216 mm TL throughout New Zealand.

275. The taking of rock lobsters with external eggs attached, the removal of those eggs, and the removal of the pleopods (or swimmerets) from the ventral surface of the tail are prohibited.

276. The taking of rock lobsters in the soft shell stage is prohibited.

277. Rock lobsters must be undamaged and able to be measured.

278. Rock lobsters must be landed whole and alive, except in the Southland (CRA 8) fishery area, where tails may be separated from the bodies at sea and the tails only landed subject to stringent hygiene, handling and reporting requirements.

279. There are three regulatory closed seasons:

a) All commercial rock lobster fishing is prohibited at the Chatham Islands (CRA 6) from 1 March to 30 April.

a) *Jasus edwardsii* less than 54/60 mm TW, but at least 127 mm tail length are permitted to be taken in Otago (CRA 7) only from 1st June to 19th November inclusive and the fishery is closed to commercial fishing for the remainder of the rock lobster fishing year.

b) For commercial fishing there is a one month (May) regulatory closure in all of CRA 3 and a three month voluntary closure (01 September to 15th January inclusive) in statistical areas 909 and 910.

280. There are seven small closed areas on the North and South Islands, which are described in the Rock Lobster Regulations. There are several regulated area closures in force on the Chatham Islands. In addition, all fishing is excluded from areas designated as marine reserves and mataitai (See Annex 1).

281. Commercial fishermen must meet prescribed standards and specifications before taking rock lobsters:

a) It is a requirement for a commercial fisherman to own a minimum quantity of ACE for the target stock before taking rock lobsters. All catch taken must be balanced with ACE for the stock. Failure to do so can result in financial penalties and permit revocation;

b) commercial fishermen can only sell catch to Licensed Fish Receivers, and they in turn can only buy product from legitimate commercial fishermen; and

c) commercial fishing can only be undertaken from a registered fishing vessel.

282. There are various requirements and restrictions governing fishing methods used by commercial fishermen:

a) the permitted method for taking rock lobsters is potting; rock lobsters taken as a by-catch from other fishing methods must be returned to the sea alive;

b) the taking of rock lobsters by free diving is permitted to a small number of qualifying persons in the CRA 6 fishery;

c) all pots and floats must be labelled with the vessel registration number; and

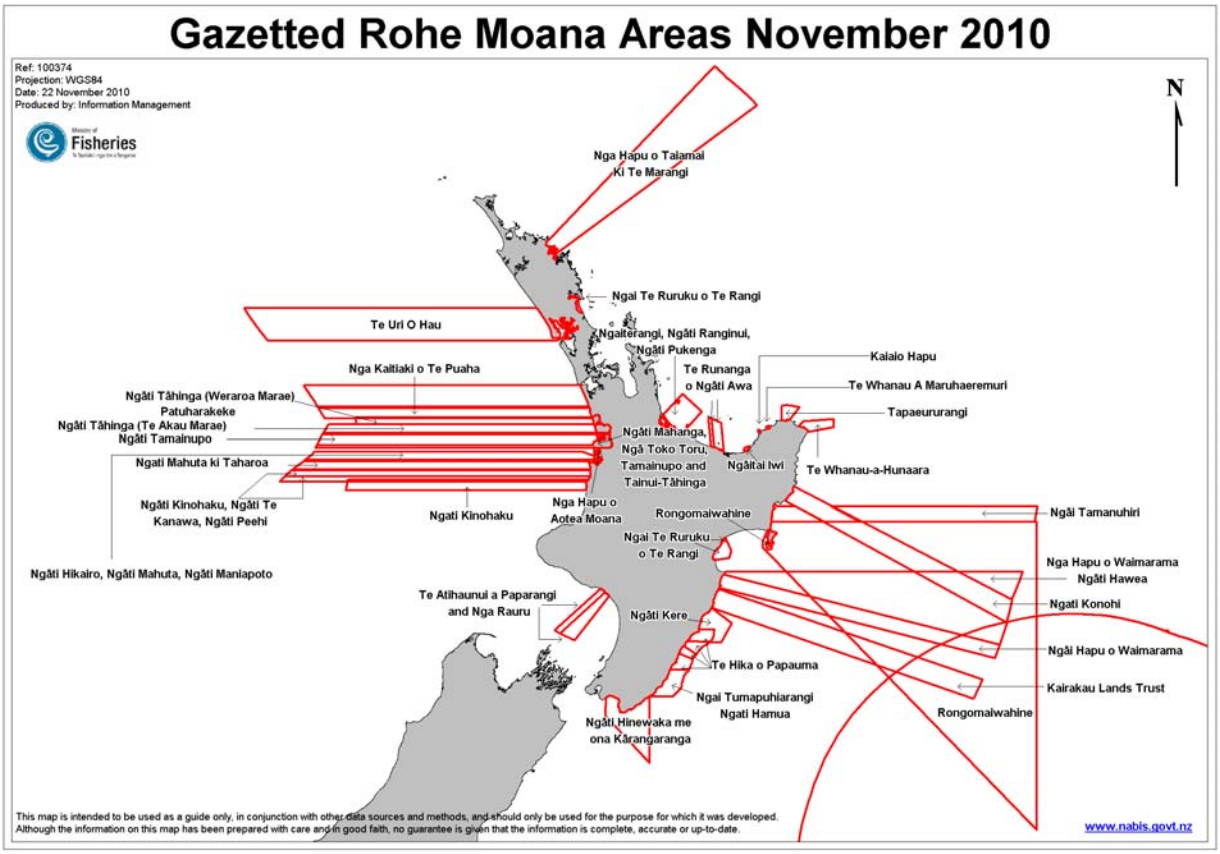
d) all pots must be fitted with Regulation escape gaps, intended to reduce sub-legal handling and predation mortalities.

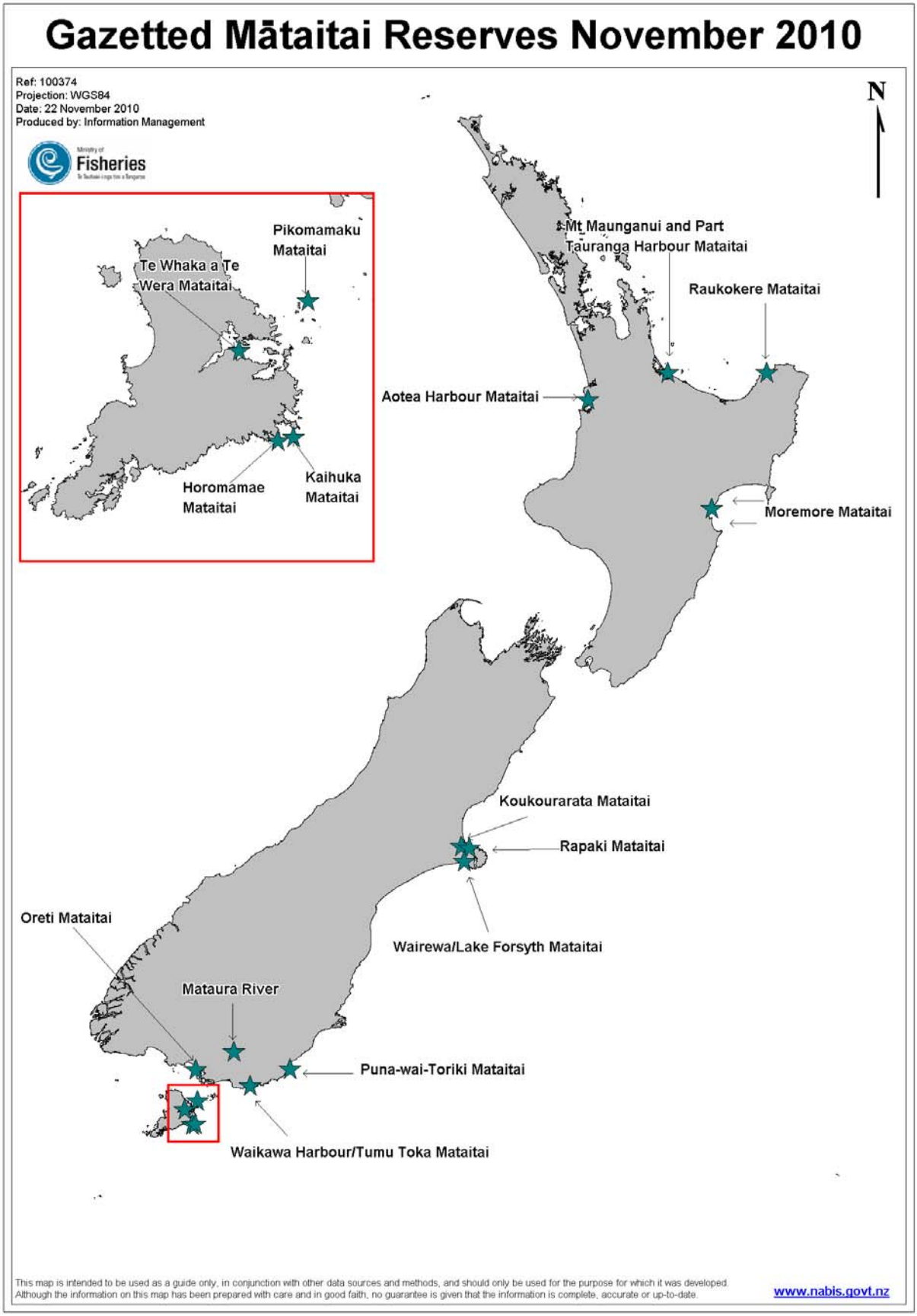
283. Amateur fishermen are prohibited from selling their catch but are permitted to catch rock lobster by any fishing method, except for the use of baited nets and explosives. Amateurs use potting, diving (freediving and underwater breathing apparatus - UBA), and hand-gathering to harvest rock lobsters, but they are restricted to a limit of six legal rock lobsters per person per day other than in Fiordland and amateur pot limits also apply – 3 pots per person to a maximum of six pots on any one vessel. Otherwise amateurs are governed by the same regulations pertaining to escapement and the state of landed lobsters as commercial fishermen.

284. Other than a regulatory prohibition on any commercial transactions related to customary take, rules pertaining to customary harvest are determined by the relevant Iwi authority but in general must ensure the sustainable utilisation of stocks.

Photo: NZRLIC/Keogh

ANNEX 1: SPATIAL DESIGNATIONS




Gazetted Mātaitai Reserves November 2010
Ref: 100374
Projection: WGS84
Date: 22 November 2010
Produced by: Information Management
Ministry of Fisheries
N
Pikomamaku Mataitai
Te Whaka a Te Wera Mataitai
Horomamae Mataitai
Kaihuka Mataitai
Mt Maunganui and Part Tauranga Harbour Mataitai
Raukokere Mataitai
Aotea Harbour Mataitai
Moremore Mataitai
Koukourarata Mataitai
Rapaki Mataitai
Oreti Mataitai
Wairewa/Lake Forsyth Mataitai
Mataura River
Puna-wai-Toriki Mataitai
Waikawa Harbour/Tumu Toka Mataitai
This map is intended to be used as a guide only, in conjunction with other data sources and methods, and should only be used for the purpose for which it was developed.
Although the information on this map has been prepared with care and in good faith, no guarantee is given that the information is complete, accurate or up-to-date.
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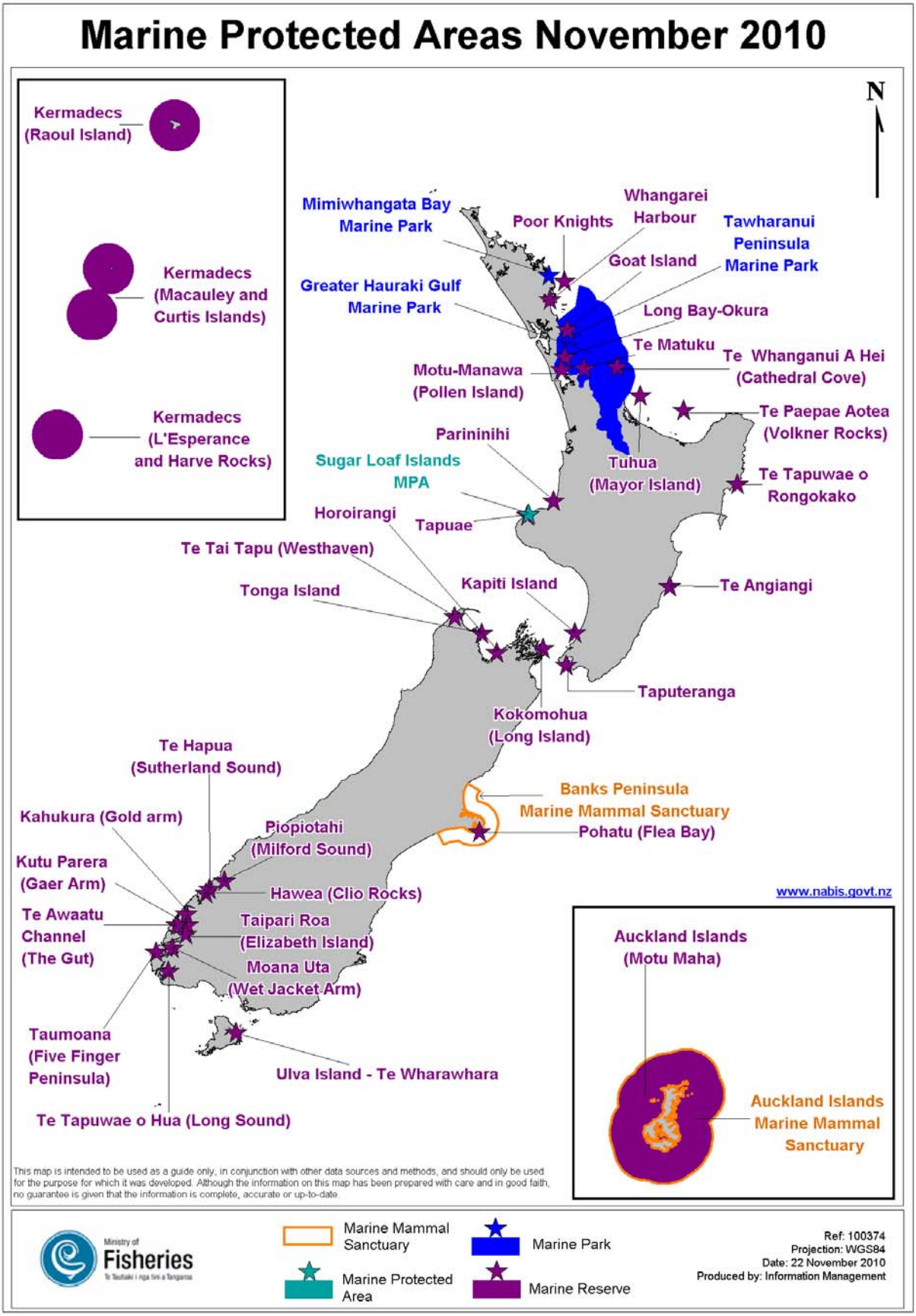
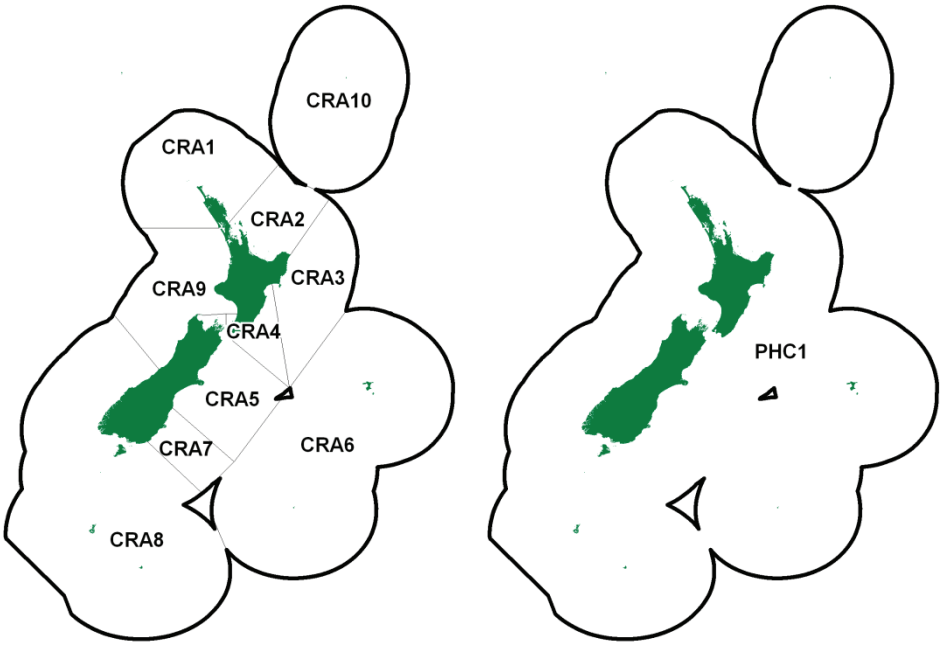

Marine Protected Areas November 2010
N
Kermadecs (Raoul Island)
Kermadecs (Macauley and Curtis Islands)
Kermadecs (L'Esperance and Harve Rocks)
Mimiwhangata Bay Marine Park
Whangarei Harbour
Poor Knights
Tawharanui Peninsula Marine Park
Goat Island
Greater Hauraki Gulf Marine Park
Long Bay-Okura
Te Matuku
Te Whanganui A Hei (Cathedral Cove)
Motu-Manawa (Pollen Island)
Te Paepae Aotea (Volkner Rocks)
Parininihi
Sugar Loaf Islands MPA
Tuhua (Mayor Island)
Te Tapuwae o Rongokako
Horoirangi
Tapuae
Te Tai Tapu (Westhaven)
Tonga Island
Kapiti Island
Te Angiangi
Taputeranga
Kokomohua (Long Island)
Te Hapua (Sutherland Sound)
Banks Peninsula Marine Mammal Sanctuary
Kahukura (Gold arm)
Piopiotahi (Milford Sound)
Pohatu (Flea Bay)
Kutu Parera (Gaer Arm)
Hawea (Clio Rocks)
www.nabis.govt.nz
Te Awaatu Channel (The Gut)
Taipari Roa (Elizabeth Island)
Moana Uta (Wet Jacket Arm)
Auckland Islands (Motu Maha)
Taumoana (Five Finger Peninsula)
Ulva Island - Te Wharawhara
Auckland Islands Marine Mammal Sanctuary
Te Tapuwae o Hua (Long Sound)
This map is intended to be used as a guide only, in conjunction with other data sources and methods, and should only be used for the purpose for which it was developed. Although the information on this map has been prepared with care and in good faith, no guarantee is given that the information is complete, accurate or up-to-date.
Ministry of Fisheries
Marine Mammal Sanctuary
Marine Park
Marine Protected Area
Marine Reserve
Ref: 100374
Projection: WGS84
Date: 22 November 2010
Produced by: Information Management

ANNEX 2: 2010 ROCK LOBSTER FISHERY ASSESSMENT PLENARY REPORT

ROCK LOBSTER (CRA and PHC)

(*Jasus edwardsii, Sagmariasus verreauxi*)
Koura papatea, Pawharu



1. FISHERY SUMMARY

Two species of rock lobsters are taken in New Zealand coastal waters. The red rock lobster (*Jasus edwardsii*) supports nearly all the landings and is caught all around the North and South Islands, Stewart Island and the Chatham Islands. The packhorse rock lobster (*Sagmariasus verreauxi*) is taken mainly in the north of the North Island. Packhorse lobsters (PHC) grow to a much larger size than do red rock lobsters (CRA) and have different shell colouration and shape.

The rock lobster fisheries were brought into the Quota Management System (QMS) on 1 April 1990, when Total Allowable Commercial Catches (TACCs) were set for each Quota Management Area (QMA) shown above. Before this, rock lobster fishing was managed by input controls, including minimum legal size (MLS) regulations, a prohibition on the taking of berried females and soft-shelled lobsters, and some local area closures. Most of the input controls have been retained, but the limited entry provisions were removed and allocation of individual transferable quota (ITQ) was made to the previous licence holders based on catch history.

Historically, three rock lobster stocks were recognised for stock assessment purposes:

- NSI – the North and South Island (including Stewart Island) red rock lobster stock
- CHI – the Chatham Islands red rock lobster stock
- PHC – the New Zealand packhorse rock lobster stock

In 1994, the Rock Lobster Fishery Assessment Working Group (RLFAWG) agreed to divide the NSI stock into three substocks:

- NSN – the northern stocks CRA 1 and 2
- NSC – the central stocks CRA 3, 4 and 5
- NSS – the southern stocks CRA 7 and 8

CRA 9 has not been assigned to a substock. Since 2001, assessments have generally been carried out at the Fishstock level, i.e. for CRA 1, CRA 2 etc.

Time series of commercial landings and catch per unit effort (CPUE) data are provided for stocks NSI, NSN, NSC, NSS and CHI for comparison with earlier years. The fishing year runs from 1 April to 31 March.

The NSI stock is composed of the CRA QMAs 1–5 and 7–9, each being a separate Fishstock with a separate TACC. The sum of the TACCs for the NSI stock was set at 3 275 t for the year commencing 1 April 1990. This total was reduced in each year until 1993–94 to reach 2 382 t (taking into account some increases in individual ITQs resulting from appeals over catch histories by fishers). The total TACC for the NSI stock then fluctuated at a level of 2 300 to 2 400 t to the 2005–06 season, when the NSI TACC dropped to 2 229 t through a reduction to the CRA 3 TACC from 327 t to 190 t (Table 1). The CRA 3 TAC dropped at the same time from 453 t to 319 t. The total NSI TACC increased in 2006–07 to 2 407 t through increases to the CRA 7 and CRA 8 TACCs from the operation of the NSS Decision Rule in 2005. The operation of the NSS Decision Rule resulted in increases to the CRA 7 and CRA 8 TACCs in both 2008–09 and 2009–10, followed by a 50% drop in the CRA 7 TACC and no change to the CRA 8 TACC for 1 April 2010 (Table 1). CRA 4 stakeholders took voluntary reductions in their effective TACC by agreeing to a shelving of ACE (annual catch entitlement) in both 2007–08 (to 340 t) and 2008–09 (to 250 t). The Ministry adopted a formal management procedure (MP) for CRA 4 in 2009, which decreased the CRA 4 TACC from 577 t to 266 t for the 2009–10 fishing year and increased the TACC to 417 t for 1 April 2010 (Table 1) (The increase would have been larger under the MP but the Minister of Fisheries opted to forego part of the increase based on recommendations from a number of stakeholders, including CRA 4 commercial fishermen). The TACC for CRA 3 was also decreased from 190 t to 164 t for the 2009–10 fishing year. The Minister adopted a formal MP for CRA 3 in 2010, which resulted in no TACC change for 1 April 2010. The NSI TACC for rock lobster in 2010–11 is 2 447 t, a slight increase over the 2009–10 value of 2 4702 t.

The TACC for the CHI stock (CRA 6) was set at 518 t in 1990 but increased through appeals to 531 t by the beginning of the 1993–94 fishing year (Table 1). The CHI TACC was subsequently reduced to 400 t in 1997–98 and to 360 t in 1998–99. CRA 10 comprises the Kermadec Islands, and has a nominal TACC of 0.086 t. The TACC for PHC increased from 27 t in 1990 to its current value of 40.3 t at the beginning of the 1993–94 fishing year following appeals.

TACs (Total Allowable Catch including non-commercial catches) were set for the first time in 1997–98 for three CRA QMAs (Table 1). Setting TACs is a requirement under the Fisheries Act 1996 and consequently TACs have been set since 1997–98 whenever adjustments have been made to the TACCs. Figure 1 shows historical landings and TACC values for all CRA stocks.

The MLS in the commercial fishery for red rock lobster is based on tail width (TW), except in the Otago fishery. For Otago (CRA 7), the MLS is a tail length (TL) of 127 mm, which has applied to both sexes during the period 21 June to 19 November, the primary commercial season. The starting date for the CRA 7 commercial fishing season was changed to 1 June on 1 October 2009. The female MLS in all other rock lobster QMAs except Southern (CRA 8) has been 60 mm TW since mid-1992. For Southern (CRA 8), the female MLS has been 57 mm TW since 1990. The male MLS has been 54 mm TW since 1988, except in Otago (MLS described above) and Gisborne (CRA 3), where it is 52 mm TW for the June-August period.

Special conditions have applied to the Gisborne (CRA 3) fishery from April 1993. During June, July and August, commercial fishers are permitted to retain males at least 52 mm TW but females cannot be landed. These measures changed the commercial CRA 3 fishery to a mainly winter fishery for male lobsters from 1993 to 2002. The fishery was closed to all users from September to the end of November from 1993. This changed in 2000, when the beginning date for the closure was changed to 1 October. In 2002, the closed season was shortened further and CRA 3 now remains officially closed to commercial fishers only in May. Commercial fishers in 2008–09 and 2009–10 have closed, by voluntary agreement, Statistical Areas 909 and 910 from the beginning of September to mid-January and Statistical Area 911 from mid-December to mid-January. Fishers in Statistical Area 911 have voluntarily landed only males above 54 mm TW in June to August 2009 and 2010.

For recreational fishers, the red rock lobster MLS has been 54 mm TW for males since 1990 and 60 mm TW for females since 1992 in all areas of NZ. The commercial and recreational MLS measure for packhorse rock lobster is 216 mm TL for both sexes.

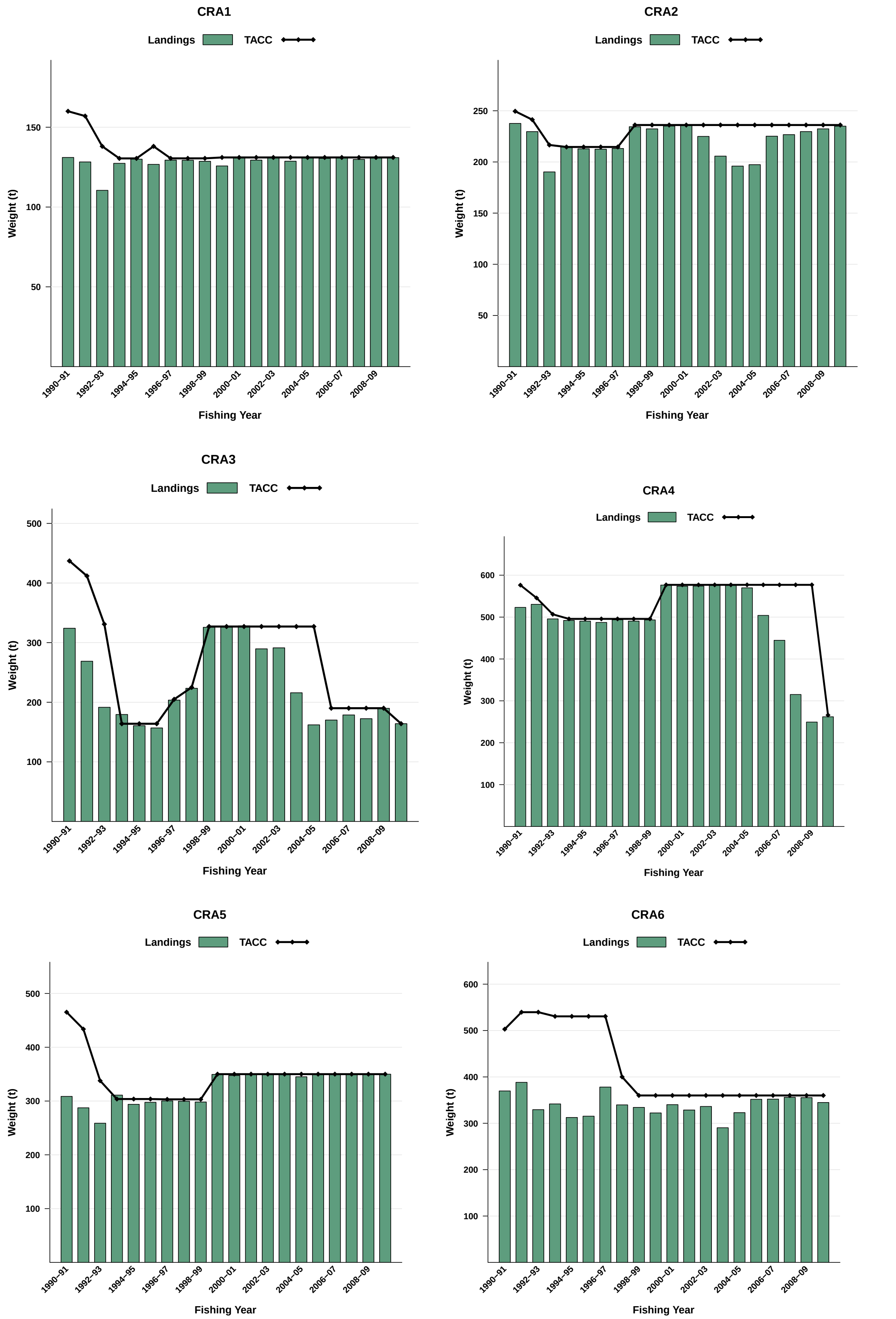


Figure 1: Historical landings and TACC for the 9 main CRA stocks and PHC 1. **[Continued on next page]**

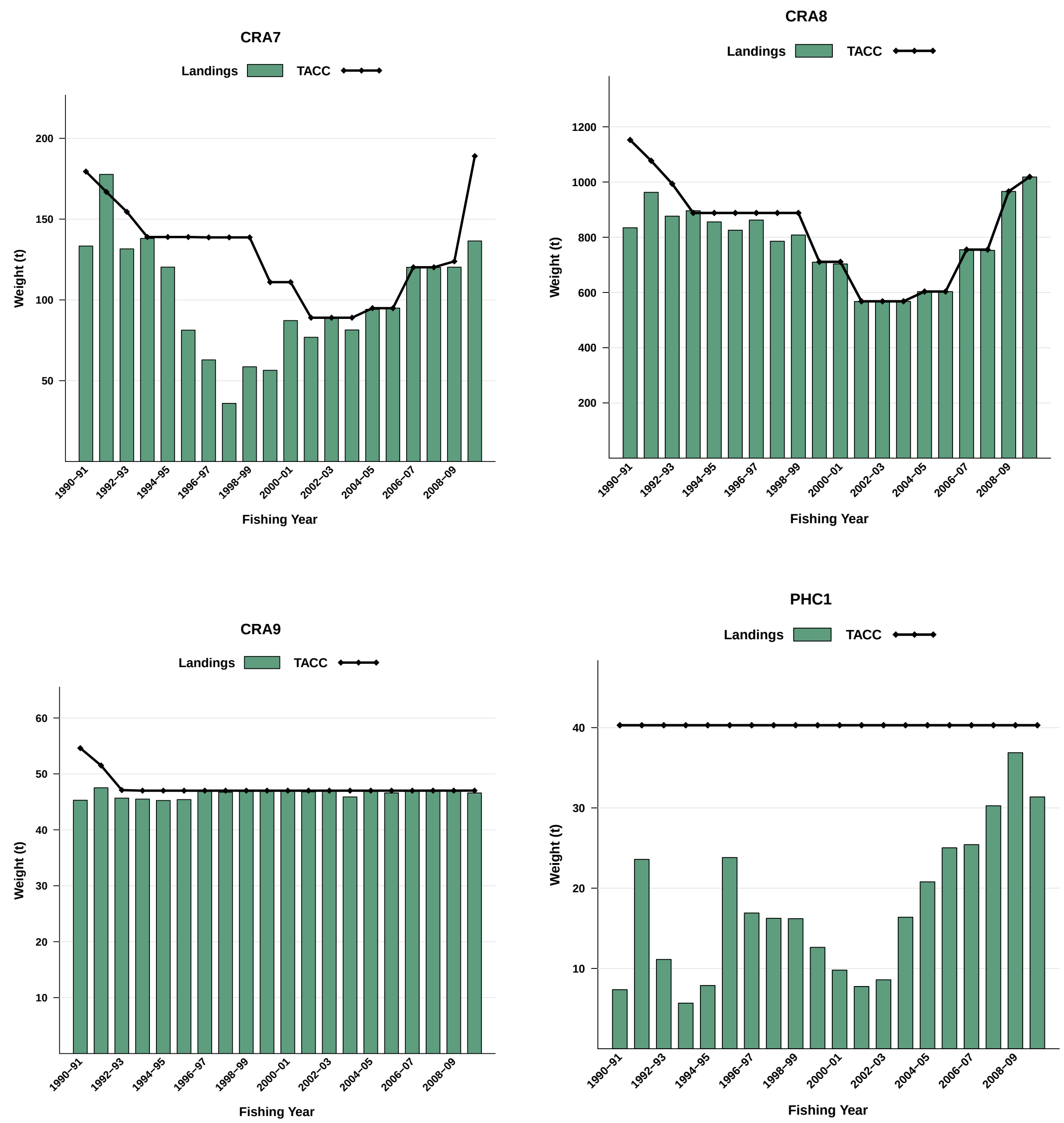


Figure 1 [Continued]: Historical landings and TACC for the 9 main CRA stocks and PHC 1.

1.1 Commercial fisheries

Table 1 provides a summary by fishing year of the reported commercial catches, TACCs and TACs by Fishstock (CRA). The Quota Management Reports (QMRs) and their replacement Monthly Harvest Reports (MHRs; since 1 October 2001) provide the most accurate information on landings. Other sources of annual catch estimates include the Licensed Fish Receiver Returns (LFRRs) and the Catch, Effort, and Landing Returns (CELRs). In recent years, landings reported by LFRRs have been close to the QMR totals (Table 2 in Starr 2009).

Table 1: Reported commercial catch (t) from QMRs or MHRs (after 1 October 2001), commercial TACC (t) and total TAC (t) (where this quantity has been set) for *Jasus edwardsii* by rock lobster QMA for each fishing year since the species was included in the QMS on 1 April 1990. –:TAC not set for QMA; N/A: catch not available (current fishing year).

	CRA 1			CRA 2			CRA 3			CRA 4		
Fishing Year	Catch	TACC	TAC	Catch	TACC	TAC	Catch	TACC	TAC	Catch	TACC	TAC
1990–91	131.1	160.1	–	237.6	249.5	–	324.1	437.1	–	523.2	576.3	–
1991–92	128.3	146.8	–	229.7	229.4	–	268.8	397.7	–	530.5	529.8	–
1992–93	110.5	137.4	–	190.3	214.6	–	191.5	327.5	–	495.7	495.7	–
1993–94	127.4	130.5	–	214.9	214.6	–	179.5	163.7	–	492.0	495.7	–
1994–95	130.0	130.5	–	212.8	214.6	–	160.7	163.7	–	490.4	495.7	–
1995–96	126.7	130.5	–	212.5	214.6	–	156.9	163.7	–	487.2	495.7	–
1996–97	129.4	130.5	–	213.2	214.6	–	203.5	204.7	–	493.6	495.7	–
1997–98	129.3	130.5	–	234.4	236.1	452.6	223.4	224.9	379.4	490.4	495.7	–
1998–99	128.7	131.1	–	232.3	236.1	452.6	325.7	327.0	453.0	493.3	495.7	–
1999–00	125.7	131.1	–	235.1	236.1	452.6	326.1	327.0	453.0	576.5	577.0	771.0
2000–01	130.9	131.1	–	235.4	236.1	452.6	328.1	327.0	453.0	573.8	577.0	771.0
2001–02	130.6	131.1	–	225.0	236.1	452.6	289.9	327.0	453.0	574.1	577.0	771.0
2002–03	130.8	131.1	–	205.7	236.1	452.6	291.3	327.0	453.0	575.7	577.0	771.0
2003–04	128.7	131.1	–	196.0	236.1	452.6	215.9	327.0	453.0	575.7	577.0	771.0
2004–05	130.8	131.1	–	197.3	236.1	452.6	162.0	327.0	453.0	569.9	577.0	771.0
2005–06	130.5	131.1	–	225.2	236.1	452.6	170.1	190.0	319.0	504.1	577.0	771.0
2006–07	130.8	131.1	–	226.7	236.1	452.6	178.7	190.0	319.0	444.6	577.0	771.0
2007–08	129.8	131.1	–	229.7	236.1	452.6	172.4	190.0	319.0	315.2[1]	577.0	771.0
2008–09	131.0	131.1	–	232.3	236.1	452.6	189.8	190.0	319.0	249.4[1]	577.0	771.0
2009–10	130.9	131.1	–	235.0	236.1	452.6	164.0	164.0	293.0	262.0	266.0	461.0
2010–11	N/A	131.1	–	N/A	236.1	452.6	N/A	164.0	293.0	N/A	415.6	610.6

	CRA 5			CRA 6			CRA 7			CRA 8		
Fishing Year	Catch	TACC	TAC	Catch	TACC	TAC	Catch	TACC	TAC	Catch	TACC	TAC
1990–91	308.6	465.2	–	369.7	518.2	–	133.4	179.4	–	834.5	1152.4	–
1991–92	287.4	426.8	–	388.3	503.0	–	177.7	164.7	–	962.7	1054.6	–
1992–93	258.8	336.9	–	329.4	503.0	–	131.6	153.1	–	876.5	986.8	–
1993–94	311.0	303.2	–	341.8	530.6	–	138.1	138.7	–	896.1	888.1	–
1994–95	293.9	303.2	–	312.5	530.6	–	120.3	138.7	–	855.6	888.1	–
1995–96	297.6	303.2	–	315.3	530.6	–	81.3	138.7	–	825.6	888.1	–
1996–97	300.3	303.2	–	378.3	530.6	–	62.9	138.7	–	862.4	888.1	–
1997–98	299.6	303.2	–	338.7	400.0	480.0	36.0	138.7	–	785.6	888.1	–
1998–99	298.2	303.2	–	334.2	360.0	370.0	58.6	138.7	–	808.1	888.1	–
1999–00	349.5	350.0	467	322.4	360.0	370.0	56.5	111.0	131.0	709.8	711.0	798.0
2000–01	347.4	350.0	467	342.7	360.0	370.0	87.2	111.0	131.0	703.4	711.0	798.0
2001–02	349.1	350.0	467	328.7	360.0	370.0	76.9	89.0	109.0	572.1	568.0	655.0
2002–03	348.7	350.0	467	336.3	360.0	370.0	88.6	89.0	109.0	567.1	568.0	655.0
2003–04	349.9	350.0	467	290.4	360.0	370.0	81.4	89.0	109.0	567.6	568.0	655.0
2004–05	345.1	350.0	467	323.0	360.0	370.0	94.2	94.9	114.9	603.0	603.4	690.4
2005–06	349.5	350.0	467	351.7	360.0	370.0	95.0	94.9	114.9	603.2	603.4	690.4
2006–07	349.8	350.0	467	352.1	360.0	370.0	120.2	120.2	140.2	754.9	755.2	842.2
2007–08	349.8	350.0	467	356.0	360.0	370.0	120.1	120.2	140.2	752.4	755.2	842.2
2008–09	349.7	350.0	467	355.3	360.0	370.0	120.3	123.9	143.9	966.0	966.0	1053.0
2009–10	349.9	350.0	467	344.8	360.0	370.0	136.5	189.0	209.0	1018.3	1019.0	1110.0
2010–11	N/A	350.0	467	N/A	360.0	370.0	N/A	84.5	104.5	N/A	1019.0	1110.0

	CRA 9			Total		
Fishing Year	Catch	TACC	TAC	Catch[1]	TACC[1]	TAC[1]
1990–91	45.3	54.7	–	2907.4	3793.0	–
1991–92	47.5	50.2	–	3020.9	3502.9	–
1992–93	45.7	47.0	–	2629.9	3201.9	–
1993–94	45.5	47.0	–	2746.2	2912.1	–
1994–95	45.2	47.0	–	2621.5	2912.1	–
1995–96	45.4	47.0	–	2548.6	2912.1	–
1996–97	46.9	47.0	–	2690.5	2953.1	–
1997–98	46.7	47.0	–	2584.2	2864.1	1312.0
1998–99	46.9	47.0	–	2726.0	2926.8	1275.6
1999–00	47.0	47.0	–	2748.5	2850.2	3442.6
2000–01	47.0	47.0	–	2795.9	2850.2	3442.6
2001–02	46.8	47.0	–	2593.0	2685.2	3277.6
2002–03	47.0	47.0	–	2591.1	2685.2	3277.6
2003–04	45.9	47.0	–	2451.5	2685.2	3277.6
2004–05	47.0	47.0	–	2472.3	2726.4	3318.8
2005–06	46.6	47.0	–	2475.8	2589.4	3184.8
2006–07	47.0	47.0	–	2604.8	2766.6	3362.0
2007–08	47.0	47.0	–	2472.5	2766.6	3362.0
2008–09	47.0	47.0	–	2640.7	2981.0	3576.5
2009–10	46.6	47.0	–	2688.1	2762.2	3362.6
2010–11	N/A	47.0	–	N/A	2807.3	3407.7

[1]ACE was shelved voluntarily by the CRA 4 Industry: to 340 t in 2007–08 and 250 t in 2008–09

Problems with rock lobster commercial catch and effort data

There are two types of data on the Catch Effort Landing Return (CELR) form: the top part of each form contains the fishing effort and an estimated catch associated with that effort. The bottom part of the form contains the actual landed catch, which may span several records of effort. Estimated catches from the top part of the CELR form may show differences from the catch totals on the bottom part of the form, particularly in some QMAs such as CRA 5 and CRA 8 (Vignaux & Kendrick 1998; Bentley et al. 2005). Substantial discrepancies were identified in 1997 between the estimated and weighed catches in CRA 5 (Vignaux & Kendrick 1998) and were attributed to fishers including all rock lobster catch in the estimated total, including those returned to the sea. This led to an overestimate of CPUE, but this problem appeared to be confined to CRA 5 which was quickly remedied by providing additional instruction to fishers on how to properly complete the forms.

After 1998, all CELR catch data have been modified to reflect the actual landed catch (bottom of form) rather than the estimated catch (top of form). This resulted in changes to the CPUE values compared to those reported before 1998.

In 2003, it was concluded that the method used to correct estimated to landed catch ("Method C1", Bentley et al. 2005) was biased because it dropped trips with no reported landings, leading to estimates of CPUE which were too high. In some areas, this bias was getting worse because of an increasing trend of passing catches through holding pots to maximise the value of the catch. The catch/effort data system operated by MFish makes no attempt to link catch derived from the effort expended on a trip with the landings recorded from the trip. Therefore, catches from previous trips, held in holding pots, can be combined with landings from the active trip, which in turn means that tracing capture from the fishing event to the landing event for the same lobster is not possible under the current system.

The catch and effort data used in these analyses have been calculated using a revised procedure since 2003. This procedure sums all landings and effort for a vessel within a calendar month and allocates the landings to statistical areas based on the reported area distribution of the estimated catches. The revised method assumes that landings from holding pots tend to even out at the month level. However, in some areas there are vessel/month combinations with no landings, indicating that the problem has not been completely solved by this approach. In these instances, the method is modified by dropping all data for the vessel in the month with zero landings and the following month; it is thought that a method that excludes uncertain data is preferable to one that might incorrectly reallocate landings. This method is described as "Method B4" in Bentley et al. (2005).

The arithmetic CPUE estimates in Tables 2 and 3 have been subjected to the same error screening as those used for standardised CPUE analysis. For arithmetic estimates, CPUE is calculated from the sum of catch divided by the sum of pots for each stock, sub-stock or CRA Fishstock by fishing year.

Another potential problem with assuming CPUE indices are proportional to abundance has been identified by the RLFAWG Group. Fishers may sort their catch, discarding parts not expected to provide a reasonable economic return. This "high-grading" (permitted by legislation) could lead to biases in the estimated CPUE, relative to previous years when sorting did not occur, if fishermen do not report the catch they could legally have retained. The practice has become more prevalent in recent years, especially in areas where rock lobster abundance has increased. The RLFAWG agreed to identify this issue for further investigation.

***Jasus edwardsii*, NSI stock**

NSI landings were relatively stable from about 1960 until the late 1980s, when they declined (Table 2) was around 1.0 kg per potlift in the late 1970s and early 1980s, and decreased slowly until the late 1980s. Catch per pot lift in NSI declined to 0.48 kg in 1992–93 and has since recovered to levels above 1.0 kg per potlift in 2008–09 (1.26) and 2009–10 (1.33) (Table 2).

Table 2: Reported commercial landings (t) to 31 March 2010 and CPUE (kg/potlift) for *Jasus edwardsii* NSI and CHI stocks, and NSN, NSC and NSS substocks, for the 1979–80 to 2009–10 fishing years. Sources of data: catch and CPUE data from 1979–80 to 1985–86 from the QMS-held FSU data; catch data from 1986-87 to 2009–10 from QMR or MHR reports held by the Ministry of Fisheries (total catches in 1986–87 and 1987–88 have been divided among substocks using the FSU data because the QMR did not report individual CRA QMAs in those years); CPUE data from 1986–87 to 1988–89 from the QMS-held FSU data; CPUE data from 1989–90 to 2009–10 from the CELR data held by the Ministry of Fisheries corrected for actual landings. See Booth et al. (1994) for a discussion of problems with the QMS-held FSU data.

					NSI Substocks		NSI Total			CHI
Fishing	NSN (CRA1 & 2)		NSC (CRA3, 4 & 5)		NSS (CRA7 & 8)		CRA 1–5 & CRA 7–9			CRA6
Year	Landings	CPUE	Landings	CPUE	Landings	CPUE	Landings	CPUE	Landings	CPUE
1979–80	408	0.57	1 386	0.85	2 129	1.58	4 012	1.06	400	2.33
1980–81	626	0.69	1 719	0.88	1 761	1.49	4 203	1.02	356	2.18
1981–82	574	0.66	1 664	0.85	1 663	1.48	3 973	0.99	465	2.19
1982–83	549	0.59	2 213	0.91	1 632	1.35	4 453	0.96	472	1.78
1983–84	506	0.55	2 303	0.85	1 634	1.09	4 514	0.87	548	1.73
1984–85	482	0.51	2 294	0.76	1 741	1.09	4 598	0.82	492	1.35
1985–86	556	0.54	2 227	0.71	2 185	1.21	5 048	0.83	604	1.41
1986–87	486	0.48	2 144	0.72	1 927	1.07	4 650	0.79	580	1.66
1987–88	442	0.45	1 781	0.57	1 961	1.12	4 277	0.72	448	1.48
1988–89	401	0.45	1 399	0.51	1 262	0.80	3 087	0.58	450	1.40
1989–90	427	0.55	1 457	0.53	1 352	0.80	3 262	0.62	318	1.34
1990–91	369	0.55	1 156	0.46	968	0.75	2 538	0.56	370	1.38
1991–92	358	0.49	1 087	0.41	1 140	0.82	2 633	0.54	388	1.29
1992–93	301	0.44	946	0.40	1 008	0.62	2 300	0.48	329	1.14
1993–94	342	0.51	983	0.49	1 034	0.87	2 404	0.61	342	1.07
1994–95	343	0.61	945	0.60	976	0.79	2 309	0.67	313	1.07
1995–96	339	0.77	942	0.73	907	0.76	2 233	0.75	315	1.09
1996–97	343	0.87	997	0.88	925	0.74	2 312	0.83	378	1.02
1997–98	364	0.87	1 013	1.15	822	0.66	2 246	0.87	339	0.88
1998–99	361	0.95	1 117	1.22	867	0.71	2 392	0.94	334	1.17
1999–00	361	0.82	1 252	1.24	766	0.73	2 426	0.96	322	1.19
2000–01	366	0.83	1 249	1.21	791	0.81	2 453	0.98	343	1.15
2001–02	356	0.71	1 213	1.08	649	0.81	2 264	0.91	329	1.15
2002–03	336	0.58	1 216	1.01	656	0.94	2 255	0.89	336	1.16
2003–04	325	0.58	1 142	1.04	649	1.31	2 161	0.99	290	1.10
2004–05	328	0.59	1 077	0.94	697	1.36	2 149	0.96	323	1.21
2005–06	356	0.60	1 024	0.90	698	1.62	2 124	0.97	352	1.35
2006–07	358	0.69	973	0.76	875	2.07	2 253	0.99	352	1.44
2007–08	360	0.71	837	0.76	873	2.18	2 116	1.03	356	1.53
2008–09	363	0.71	789	0.89	1 086	2.91	2 285	1.26	355	1.50
2009–10	366	0.66	776	1.12	1 155	2.45	2 343	1.33	345	1.36

Jasus edwardsii, NSN substock

Landings in the NSN substock were high in the early 1980s but CPUE was less than 1.0 kg per potlift. Both measures gradually declined into the early 1990s. Catch per pot lift was around 0.7 kg in the early 1980s but the period from 1986–87 to 1992–93 had catch rates around 0.5 kg (Table 2). From 1994, CPUE increased to levels considerably higher than those observed at the beginning of the time series, peaking in 1998–99 at 0.95 kg per potlift. CPUE levels in CRA 1 and CRA 2 differ: CRA 1 maintained high catch rates (above 1.5 kg/potlift in most recent 3 fishing years) since the late 1990s, while CRA 2 declined to less than 0.5 kg/potlift in 2002–03 and has since remained near that level (Table 3). The combined NSN catch rate increased from 0.6 to 0.7 kg per potlift in 2006–07 and has remained near that level over the four most recent fishing years.

Jasus edwardsii, NSC substock

Landings in the NSC substock were very high to the mid 1980s, exceeding 2 000 t for five fishing years in succession. During that time, CPUE dropped from 0.9 kg/potlift to 0.7 kg/potlift (Table 2). Commercial catches then gradually decreased to below 1 000 t and CPUE dropped to below 0.5 kg per potlift by the early 1990s. From 1993–94, CPUE increased to a peak of 1.24 kg/potlift in 1999–2000 (Table 2). CPUE dropped to near 1.0 kg per potlift in 2002–03, and dropped to 0.76 kg/potlift in 2006–07 and 2007–08. This was still higher than the levels observed from 1987–88 to 1995–96. CPUE increased to 0.89 in the most recent year. Trends in CPUE have differed between the three component QMAs in the NSC, with CRA 3 CPUE peaking in 1997–98, CRA 4 in 1998–99, and CRA 5 in 2003–04 (Table 3).

Jasus edwardsii, NSS substock

Catches and CPUE were high for this substock: greater than 1 500 t per fishing year, with CPUE well over 1.0 kg per potlift throughout most of the 1980s. However, both measures gradually declined during that period, dropping below 1 000 t and below 1.0 kg per potlift by the early- to mid-1990s (Table 2). CPUE has been increasing since 1997–98, nearly reaching 3.0 kg per potlift in 2008–09 and above 2.0 kg/potlift in the most recent four fishing years (Table 2). Catches are relatively low in CRA 7 compared with those in the other QMAs, CPUE rose in both CRA 7 and CRA 8 up to 2009–10, with CPUE dropping by 40% in CRA 7 while remaining the same in CRA 8 (Table 3).

Jasus edwardsii, Westland/Taranaki (CRA 9)

Catch per pot lift fluctuated near 0.9 kg per potlift between 1998–99 and 2001–02, then increased to above 2 kg per potlift in 2004–05 and 2005–06, and has since decreased slowly to near 1.6 kg per potlift (Table 3).

Jasus edwardsii, CHI stock

CPUE in the CHI fishery was higher than in the other New Zealand CRA areas in the 1980s (Table 2). However, CPUE since the mid-1980s has declined to levels similar to those in other CRA QMAs (Table 3). CPUE dropped to 1.1 kg/potlift in 2003–04, increased to 1.5 kg/potlift in 2007–08 and 2008–09 and dropped to 1.4 kg/potlift in 2009–10. Landings were around 400 to 500 t per fishing year in the 1980s but fell below 400 t per year in the 1990s. The reasons for the decline in catch and in CPUE are unknown. Size frequencies of lobsters in the landed catch have changed little since the beginning of this fishery.

Table 3: Estimated arithmetic CPUE (kg/potlift) for each CRA quota management area for the ten most recent fishing years. Data are from the Ministry of Fisheries CELR database and estimated catches have been corrected by the amount of fish landed from the bottom part of the form (see Section 1 in text for explanation).

	Fishing year									
QMA	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
CRA 1	1.17	1.30	1.20	1.22	1.23	1.14	1.32	1.64	1.57	1.63
CRA 2	0.71	0.56	0.44	0.43	0.43	0.47	0.54	0.53	0.53	0.49
CRA 3	1.19	0.95	0.73	0.62	0.52	0.62	0.58	0.60	0.71	0.85
CRA 4	1.26	1.06	1.09	1.14	1.00	0.88	0.65	0.60	0.71	1.02
CRA 5	1.16	1.27	1.26	1.39	1.26	1.17	1.18	1.19	1.28	1.44
CRA 6	1.15	1.15	1.16	1.10	1.21	1.35	1.44	1.53	1.50	1.36
CRA 7	0.35	0.46	0.52	0.58	0.75	1.12	1.56	1.31	1.69	1.02
CRA 8	0.98	0.92	1.10	1.67	1.58	1.75	2.19	2.47	3.20	3.11
CRA 9	0.93	0.82	1.11	1.63	2.14	2.22	1.94	1.85	1.75	1.64

Sagmariasus verreauxi, PHC stock

QMS-reported catches of the PHC stock halved between 1998–99 and 2001-02 but have since increased to near the TACC since 2007–08 (Table 4).

Table 4: Reported landings of *Sagmariasus verreauxi* from 1990–91 to 2009–10. Data from QMR or MHR (after 1 Oct 2001).

Fishing Year	Landings (t)	Fishing Year	Landings (t)
1990–91	7.4	2000–01	9.8
1991–92	23.6	2001–02	3.4
1992–93	11.1	2002–03	8.6
1993–94	5.7	2003–04	16.4
1994–95	7.9	2004–05	20.8
1995–96	23.8	2005–06	25.0
1996–97	16.9	2006–07	25.4
1997–98	16.2	2007–08	34.0
1998–99	16.2	2008–09	36.4
1999–00	12.6	2009–10	35.7

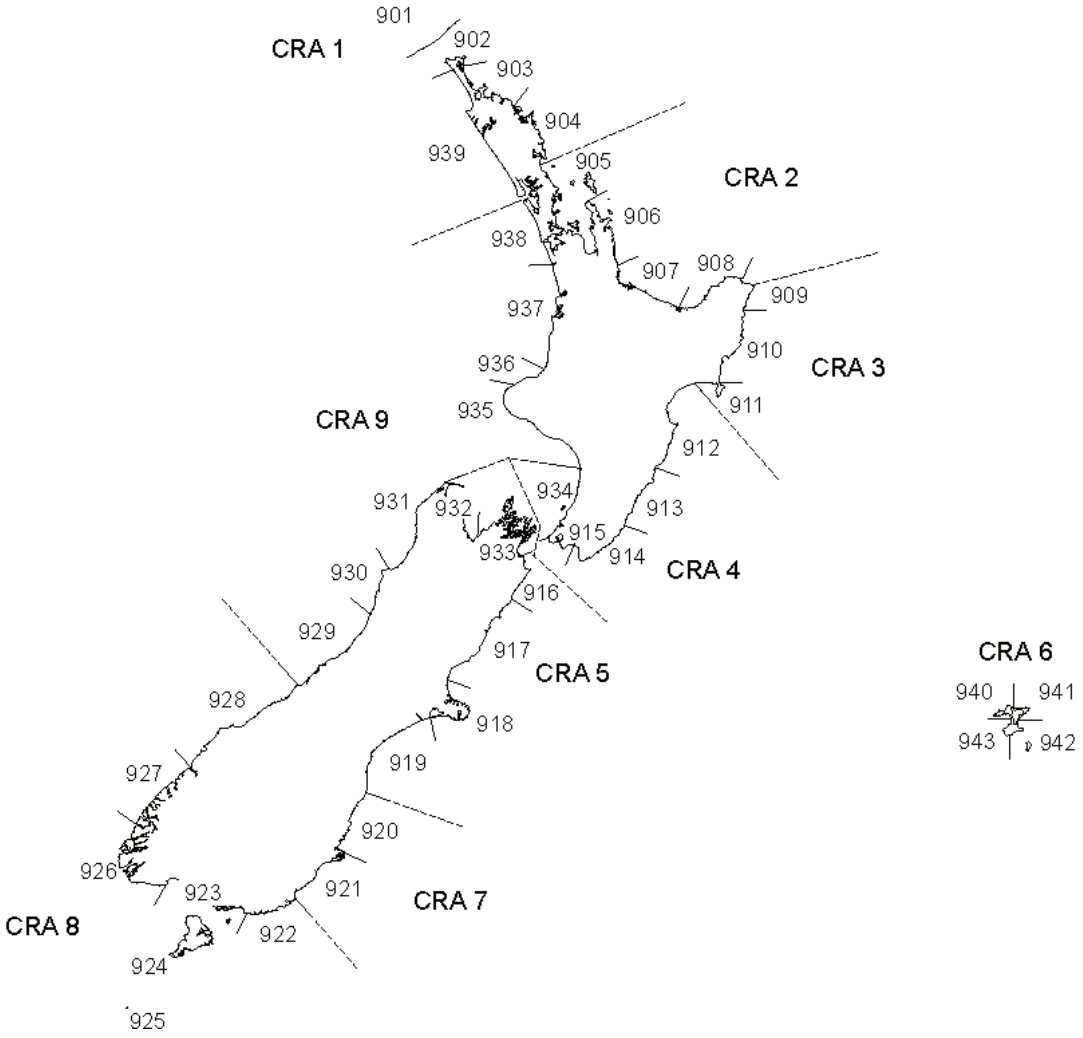


Figure 2: Rock lobster statistical areas as reported on CELR forms.

Jasus edwardsii CPUE by statistical area

Table 5 shows the CPUE for the most recent six years within each CRA QMA for each rock lobster statistical area reported on the CELR forms (Figure1). The values of CPUE and the trends in the fisheries vary within and between CRA areas.

1.2 Recreational fisheries

Recreational catches have been estimated from a series of regional and national surveys based on telephone interviews and a sub-sample of diarists. Each survey estimated the New Zealand recreational catch by scaling up the reported catch in numbers by diarists with the ratio of diarists to the total estimated New Zealand population. The catch in numbers was converted to catch in weight using mean weights of recruited lobsters observed in the appropriate catch sampling or voluntary logbook programs during the survey years. Results for rock lobster from each of these recreational surveys – South region (1991–92), Central region (1992–93), North region (1993–94), the 1996 National Diary Survey, and the 1999–2000 National survey – are presented in Table 6.

Table 5: Arithmetic CPUE (kg/potlift) for each statistical area for the six most recent fishing years. Data are from the Ministry of Fisheries CELR database and estimated catches have been corrected by the amount of fish landed from the bottom part of the form (see Section 1 in text for explanation). '–' value withheld because fewer than three vessels were fishing or there was no fishing.

CRA	Stat Area	04/05	05/06	06/07	07/08	08/09	09/10
1	901	3.56	3.20	2.96	3.48	3.99	3.50
1	902	2.06	2.37	–	2.46	1.69	2.35
1	903	1.08	0.86	1.33	1.47	1.19	0.90
1	904	0.57	–	–	0.62	–	–
1	939	0.70	0.57	0.86	1.08	1.28	2.05
2	905	0.56	0.51	0.60	0.57	0.60	0.53
2	906	0.38	0.46	0.51	0.54	0.44	0.40
2	907	0.47	0.46	0.56	0.61	0.82	0.69
2	908	0.43	0.42	0.55	0.43	0.48	0.45
3	909	0.82	0.79	0.97	1.00	1.04	1.19
3	910	0.53	0.58	0.47	0.60	0.71	0.90
3	911	0.42	0.59	0.60	0.50	0.57	0.70
4	912	0.77	0.59	0.55	0.62	0.68	0.75
4	913	1.21	0.94	0.74	0.69	0.80	1.05
4	914	1.11	0.93	0.55	0.44	0.56	1.11
4	915	0.76	0.81	0.67	0.78	0.83	1.25
4	934	–	–	1.50	0.86	–	–
5	916	2.38	2.19	2.09	2.09	2.41	2.20
5	917	1.06	1.18	1.22	1.34	1.44	2.01
5	918	1.37	1.85	–	–	1.68	–
5	919	–	–	–	–	–	–
5	932	–	–	–	–	–	–
5	933	0.89	0.72	0.72	0.72	0.74	0.76
6	940	1.12	1.21	1.23	1.37	1.35	1.08
6	941	0.88	0.90	1.00	1.13	1.31	1.16
6	942	1.49	1.65	1.89	1.96	1.63	1.61
6	943	1.00	1.49	1.91	1.39	1.44	1.23
7	920	0.53	0.94	1.34	1.13	1.66	0.80
7	921	1.32	1.81	2.02	1.99	2.02	1.73
8	922	–	–	–	–	–	1.12
8	923	2.45	4.25	2.07	4.16	3.32	–
8	924	2.00	3.00	4.04	3.18	3.17	4.13
8	925	1.13	–	–	2.87	–	–
8	926	1.96	2.21	2.63	2.28	2.92	2.60
8	927	1.72	1.17	1.72	2.89	3.65	4.09
8	928	1.41	1.68	2.13	5.33	6.25	4.22
9	929	–	–	–	–	–	–
9	930	–	–	–	–	–	–
9	931	–	–	2.94	–	–	–
9	935	2.44	1.98	1.69	1.77	2.39	–
9	936	–	–	–	–	–	–
9	937	–	1.58	–	–	–	–
9	938	–	–	–	–	–	–

Table 6: All available estimates of recreational rock lobster harvest (in numbers and in tonnes by QMA, where available) from regional telephone and diary surveys in 1992, 1993, 1994, 1996, 2000 and 2001 (Bradford 1997, 1998; Teirney et al. 1997). Data were provided by the chairman of the Recreational Fisheries Fishery Assessment Working Group (Peter Todd, MFish; pers. comm.).

QMA/FMA	Number	c.v. (%)	Nominal point estimate (t)
Recreational Harvest South Region 1 Sept 1991 to 30 Nov 1992			
CRA5	65 000	31	40
CRA7	8 000	29	7
CRA8	29 000	28	21
Recreational Harvest Central Region 1992–93			
CRA1	1 000		
CRA2	4 000		
CRA3	8 000		
CRA4	65 000	21	40
CRA5	11 000	32	10
CRA8	1 000		
Northern Region Survey 1993–94			
CRA1	56 000	29	38
CRA2	133 000	29	82
CRA9	6 000		
1996 Survey			
CRA1	74 000	18	51
CRA2	223 000	10	138
CRA3	27 000		
CRA4	118 000	14	73
CRA5	41 000	16	35
CRA7	3 000		
CRA8	22 000	20	16
CRA9	26 000		
2000 Survey			
CRA1	107 000	59	102.3
CRA2	324 000	26	235.9
CRA3	270 000	40	212.4
CRA4	371 000	24	310.9
CRA5	151 000	34	122.3
CRA7	1 000	63	1.3
CRA8	13 000	33	23.3
CRA9	65 000	64	52.8
2001 Roll Over Survey			
CRA1	161 000	68	153.5
CRA2	331 000	27	241.4
CRA3	215 000	48	168.7
CRA4	419 000	22	350.5
CRA5	226 000	22	182.4
CRA7	10 000	67	9.4
CRA8	29 000	43	50.9
CRA9	34 000	68	27.7

In previous assessments, the RLFAWG has not accepted the results from the 1999–2000 national survey and the subsequent "roll-over" survey (Table 6), both of which tended to have higher catch

estimates in most of the CRA QMAs when compared to the earlier surveys (with the exception of CRA 7 and CRA 8). Table 7 presents the recreational catch estimates used in all recent rock lobster stock assessments and Table 8 presents the rationale used when setting the levels presented in Table 7. The RLFAWG has little confidence in these estimates of recreational catch.

Table 7: Historical recreational and customary catch estimates used in recent CRA assessments. All ramped catches started from 20% of the "best recreational estimate". The rationales for setting these catches are presented in Table 8.

QMA	First year	Last year	"Best" Recreational catch (t)	Notes: Recreational Catch	Customary catch (t)	Notes: Customary catch
CRA 1 [1]	1945	2001	47.19	Ramped from 1945; constant from 1979	10	Constant from 1945
CRA 2 [1]	1945	2001	122.64	Ramped from 1945; constant from 1979	10	Constant from 1945
CRA 3 [2]	1945	2007	20.0	Constant from 1945	20	Constant from 1945
CRA 4 [3]	1945	2005	46.709	Ramped from 1945; constant from 1979	20	Constant from 1945
CRA 5 [4]	1945	2003	30.424	Ramped from 1945; after 1979, the "best recreational catch" was scaled by the ratio of the arithmetic SS CPUE for Area 917 relative to the mean 1994/1996 CPUE	10	Constant from 1945
CRA 6 [5]	–	–	–	Not used	–	–
CRA 7 [6]	1976	2006	4.514	Constant from 1976	1	Constant from 1976
CRA 8 [6]	1976	2006	20.101	Constant from 1976	2	Constant from 1976
CRA 9	–	–	–	Not used	–	–

[1] Starr et al. (2003);[2] Breen et al. (2009); [3] Breen et al. (2006); [4] see Section XX; [6] Breen et al. (2007)

Table 8: Basis for setting recreational and customary catch estimates used in recent CRA assessments. SS: spring/summer. The recreational survey estimates are provided in Table 6.

QMA	Notes: Recreational Catch	Notes: Customary Catch
CRA 1 and CRA 2 [1]	Mean of 1994 and 1996 recreational survey estimates in numbers X 1994/96 SS mean weight from catch sampling	MFish Compliance estimate
CRA 3 [2]	By WG agreement	MFish Compliance estimate
CRA 4 [3]	Mean of 1994 and 1996 recreational survey estimates in numbers X 1994/96 SS mean weight from catch sampling	MFish Compliance estimate
CRA 5 [4]	Mean of 1994 and 1996 recreational survey estimates in numbers X 1994/96 SS mean weight from catch sampling	By WG agreement
CRA 6 [5]	Not used	Not used
CRA 7 [6] CRA 8 [6]	Mean of recreational survey estimates (mean in numbers: 1992/1996 and 2000/2001) X mean SS weight from catch sampling in same years. The maximum of catches declared under the 1996 Fisheries Act Section 111 were then added to the survey estimates	Expanded from estimates provided by MFish Compliance which were thought to be too low by the WG
CRA 9	No assessment	No assessment

[1] Starr et al. (2003);[2] Breen et al. (2009); [3] Breen et al. (2006); [4] see Section XX; [6] Breen et al. (2007)

1.3 CRA 5 recreational catch

Recreational catch estimates were required for the 2010 CRA 5 assessment. The RLFAWG considered that reports of increased recreational activity in CRA 5 coupled with an increasing trend in abundance made it unlikely that recreational catches have remained constant over time. For this reason, the RLFAWG agreed to use a catch trajectory that reflected the increasing abundance of lobster in this QMA (Figure 2).

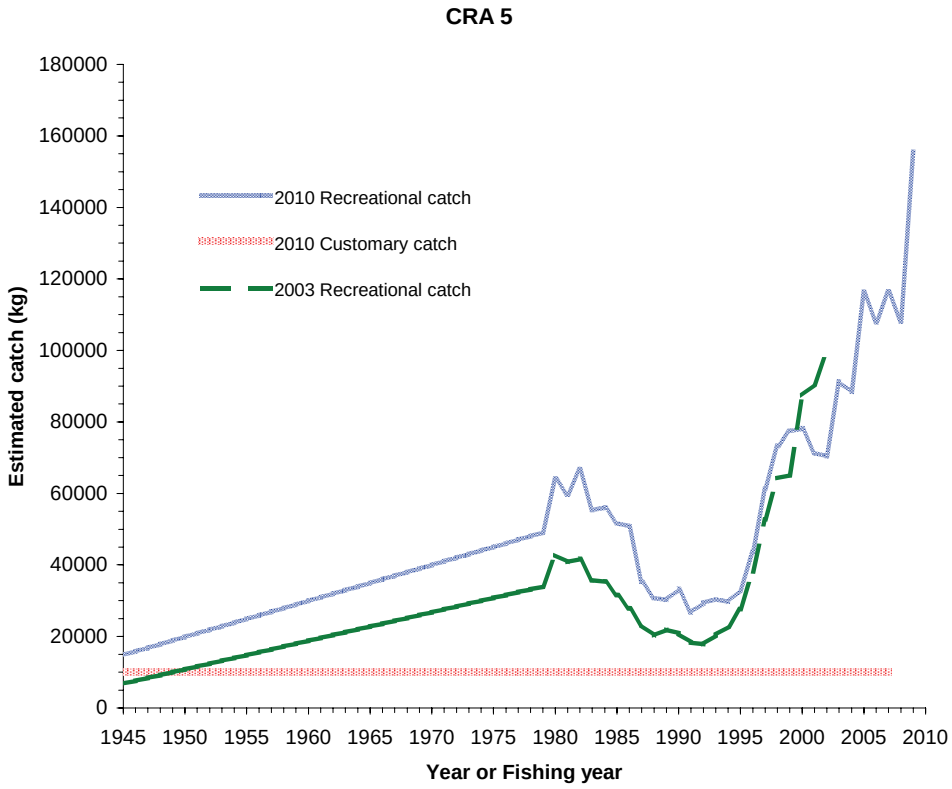


Figure 3. Recreational (blue) and customary (pink) catch trajectories (kg) for the 2010 stock assessment of CRA 5. Also plotted is the recreational catch trajectory used for the 2003 CRA 5 stock assessment (green dash). Section 111 catches have been added to the 2010 recreational catch trajectory. In 2010, recreational catches were made proportional to the Area 917 unstandardised SS CPUE after 1979, scaled to the mean catch weight estimated from the 1994 and 1996 recreational diary surveys .

The RLFAWG agreed to use the following algorithm to represent the CRA 5 recreational catches (see minutes of the meeting 22 September 2010):

$$\bar{W}_{94,96} = \bar{w}_{94,95,96} * \bar{N}_{94,96}$$

$$W_i = \frac{CPUE_i * \bar{W}_{94,96}}{0.5\left(CPUE_{94} + CPUE_{96}\right)} \quad \text{if } i >= 1979$$

$$W_{1945} = 0.2 * W_{1979}$$

$$W_i = W_{i-1} + \frac{(W_{1979} - W_{1945})}{(1979 - 1945)} \quad \text{if } i > 1945 \,\&\, i < 1979$$

where

$\bar{W}_{94,96}$ = mean recreational catch weight for 1994 & 1996

$\bar{w}_{94,95,96}$ = mean spring/summer weight >= MLS for sampled lobster

$\bar{N}_{94,96}$ = mean numbers lobster from 1994 & 1996 diary surveys

$CPUE_i$ = Area 917 spring/summer CPUE from 1979 to 2009

W_i = estimated recreational catch by weight for year i

This algorithm is similar to that adopted by the RLFAWG for the 2003 CRA 5 stock assessment, except that the spring/summer (SS) standardised CPUE indices for all of CRA 5 were used in 2003. The RLFAWG preferred to use the unstandardised CPUE only from Area 917 because this is the region (Kaikoura) where most recreational catch from CRA 5 is taken. The mean number of lobsters from the 1994 and 1996 surveys was 54,000 and the mean weight of legal lobsters in the SS, estimated from the commercial sampling data, was 0.563 kg. The resulting recreational catch trajectory (Figure 3Figure) showed a strong increasing trend since the mid-1990s, exceeding 100 t since 2005 and exceeding 150 t in 2009. Mean recreational catch for 1945 to 2009 was 41 t and since 1979 was 58 t before adding the Section 111 catch.

1.4 Section 111 commercial landings

Commercial fishermen are allowed to take home lobsters for personal use under the provisions of Section 111 of the Fisheries Act. These lobsters are required to be declared on landing forms using the destination code "F". The maximum total in any fishing year for these landings by QMA has ranged from less than 1 t (CRA 6) to greater than 10 t (CRA 8) (Table 9).

Table 9: Section 111 commercial landings (in kg, summed from landing destination code "F") by fishing year and QMA.

Fishing Year	CRA1	CRA2	CRA3	CRA4	CRA5	CRA6	CRA7	CRA8	CRA9
1992-93	5								
1999-2000					8				
2000–01	3				30				
2001–02	111	227	136	648	465		77	253	5
2002–03	489	609	495	2,660	1,960		152	1,954	907
2003–04	2,221	1,025	372	3,399	2,907	60	93	1,679	973
2004–05	3,554	733	311	3,706	3,191	87	95	3,505	1,636
2005–06	3,083	775	993	3,680	4,388	2	153	4,572	2,133
2006–07	5,016	1,284	981	3,110	5,102	19	289	5,813	1,219
2007–08	3,831	1,032	1,167	2,706	5,412	411	929	7,786	1,461
2008–09	3,628	1,185	1,374	2,188	6,110	538	1,498	9,571	1,597
2009–10	4,010	1,370	2,253	3,222	6,244	299	1,688	10,721	2,264
Maximum	5,016	1,370	2,253	3,706	6,244	538	1,688	10,721	2,264

1.5 Customary non-commercial fisheries

The Ministry of Fisheries provided preliminary estimates of the Mäori customary catch for some Fishstocks for the 1995–96 fishing year. The estimates for the 1995–96 fishing year were: CRA 1, 2.0 t, CRA 2, 16.5 t; CRA 8, 0.2 t; CRA 9, 2.0 t; and PHC 1, 0.5 t. Table 7 presents the customary catch estimates used in all recent rock lobster stock assessments and Table 8 presents the rationale used when setting the levels presented in Table 7. The RLFAWG has little confidence in these estimates.

1.6 Illegal catch

MFish Compliance has provided estimates of illegal catch in two categories: catch that subsequently was reported against quota (columns labelled 'R' in Table 10) and catch which is outside of the MFish catch reporting system (columns labelled 'NR' in Table 10). Table 10 shows all the available illegal catch estimates by CRA QMA. When these data are used in stock assessments, missing cells are filled in by interpolation (for missing years) or by extrapolation (to extend the series after 2004–05). The illegal catches for these filled-in years are apportioned between the 'R' and 'NR' categories within each QMA (q) using the mean proportion $r_q = \sum R_{q,y} \Big/ \sum I_{q,y}$, where $R_{q,y}$ is the "reported" ('R') catch for those years with MFish Compliance estimates in the QMA and $I_{q,y}$ is the total illegal catch in the same years. This quantity is then subtracted from the total reported QMR/MHR catch to avoid counting the same catch twice when using these catches in stock assessments and the total illegal catch is summed.

Table 10: Available estimates of illegal catches (t) by CRA QMA from 1990, as provided by MFish Compliance over a number of years. R (reported): illegal catch that will eventually be processed though the legal catch/effort system; NR (not reported): illegal catch outside of the catch/effort system. Cells without data or missing rows have been deliberately left blank.

	CRA 1		CRA 2		CRA 3		CRA 4		CRA 5		CRA 6		CRA 7		CRA 8		CRA 9	
Year	R	NR	R	NR	R	NR	R	NR	R	NR	R	NR	R	NR	R	NR	R	NR
1990		38		70		288.2		160.1		178		85	34	9.6	25	5		12.8
1992		11		37		250		30		180		70	34	5	60	5		31
1994		15		70	5	37		70		70		70		25		65		18
1995		15		60	0	63		64		70		70		15		45		12
1996	0	72	5	83	20	71	0	75	0	37	70	0	15	5	30	28	0	12
1997					4	60												
1998					4	86.5												
1999					0	136								23.5		54.5		
2000					3	75		64										
2001		72		88	0	75												
2002					0	75	9	51		40		10		1		18		1
2003					0	89.5			5	47								
2004							10	30										

Table 11: Export discrepancy estimates by year for all of New Zealand (McKoy, pers. comm.). The QMA export discrepancy catch is calculated using the fraction for the reported QMA commercial catch $C_{q,y}$ relative to the total NZ commercial catch C_y, starting with the total NZ export discrepancy for that year I_y: $I_{q,y} = I_y\left(C_{q,y}/C_y\right)$. This calculation is not performed for CRA 9 as there were no estimates of commercial catch available from 1974 to 1978. The average ratio of the export discrepancy catch for each QMA $\bar{P}_q$ relative to the reported QMA commercial catches is used in each CRA QMA to estimate illegal catches prior to 1990: $I_{q,y} = \bar{P}_q C_{q,y}$ if $y<1974 \| \left(y>1980 \& y<1990\right)$.

Year	Estimates of total export discrepancies (t) I_y	QMA	$\bar{P}_q = \sum_{y=1974}^{1980} I_{q,y} \Big/ \sum_{y=1974}^{1980} C_{q,y}$
1974	463	CRA 1	0.192
1975	816	CRA 2	0.171
1976	721	CRA 3	0.164
1977	913	CRA 4	0.183
1978	1146	CRA 5	0.187
1979	383	CRA 6	0.181
1980	520	CRA 7	0.183
		CRA 8	0.187
		CRA 9	–

Illegal catch estimates prior to 1990 have been derived from unpublished estimates of discrepancies between reported catch totals and total exported weight (Table 11; McKoy pers. comm.) that were developed for the period 1974 to 1980. For years prior to 1973 and from 1981–82 to 1989–90, illegal catch is estimated using the average ratio of annual exports of rock lobster relative to the reported catch in each year from 1974 to 1980 (Table 11). This ratio is calculated for each QMA by assuming that the exports are distributed by QMA in the same proportion as the reported catches. This procedure does not work for CRA 9 because there are no commercial catch estimates available for this QMA from 1974 to 1978.

The RLFAWG members have little confidence in the estimates of illegal catch, because the estimates cannot be verified.

1.7 Other sources of mortality

Other sources of mortality include handling mortality caused by the return of under-sized and berried female lobsters to the water, and predation by octopus and other predators within pots. Although these cannot be quantified, all recent rock lobster assessments assume that handling mortality is 10% of returned lobsters.

1.8 Time series of mortalities

Plots of rock lobster catches from 1945 are presented in Figure 4. Commercial catches prior to 1979 have been obtained from unpublished reports (Annala, pers. comm.). Historical estimates of recreational, customary and illegal catches have been generated for each stock assessment and these have been extended using the same rules for those assessments that are not current. In some instances

(notably CRA 9), there has never been a stock assessment and some catch components are missing for this QMA. Finally, a TAC is plotted for the 7 CRA QMAs which have one.

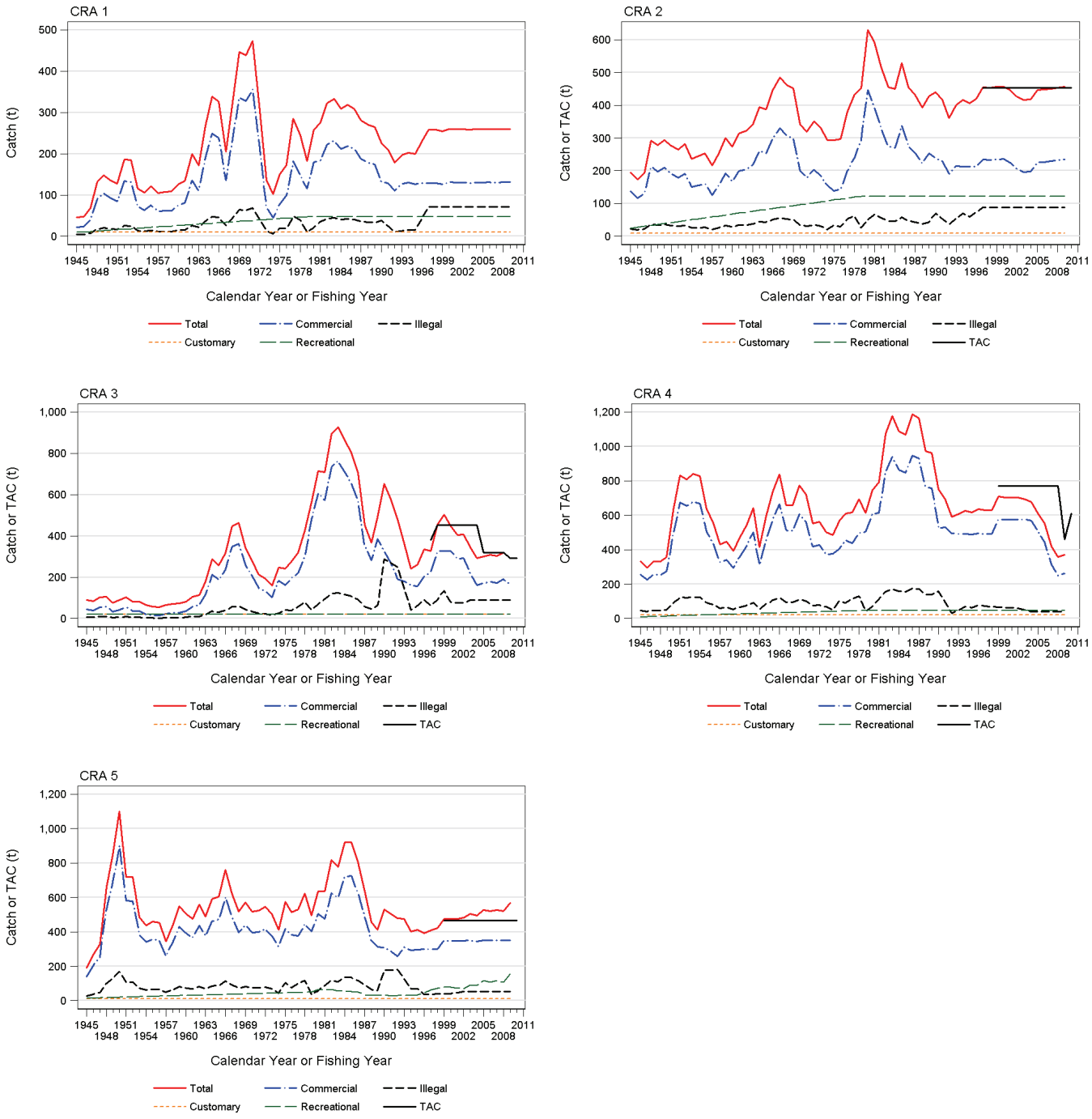


Figure 4: Catch trajectories (t) from 1945 to 2010 for CRA 1 to CRA 5, showing current best estimates for commercial, recreational, customary and illegal categories. Also shown is the sum of these four catch categories and the TAC (t) if it exists. Note that calendar year catches are plotted from 1945 to 1977. Statutory fishing years (1 April to 31 March) catches are plotted from 1979 on. Catches for 1978 are for 15 months, including January to March 1979.

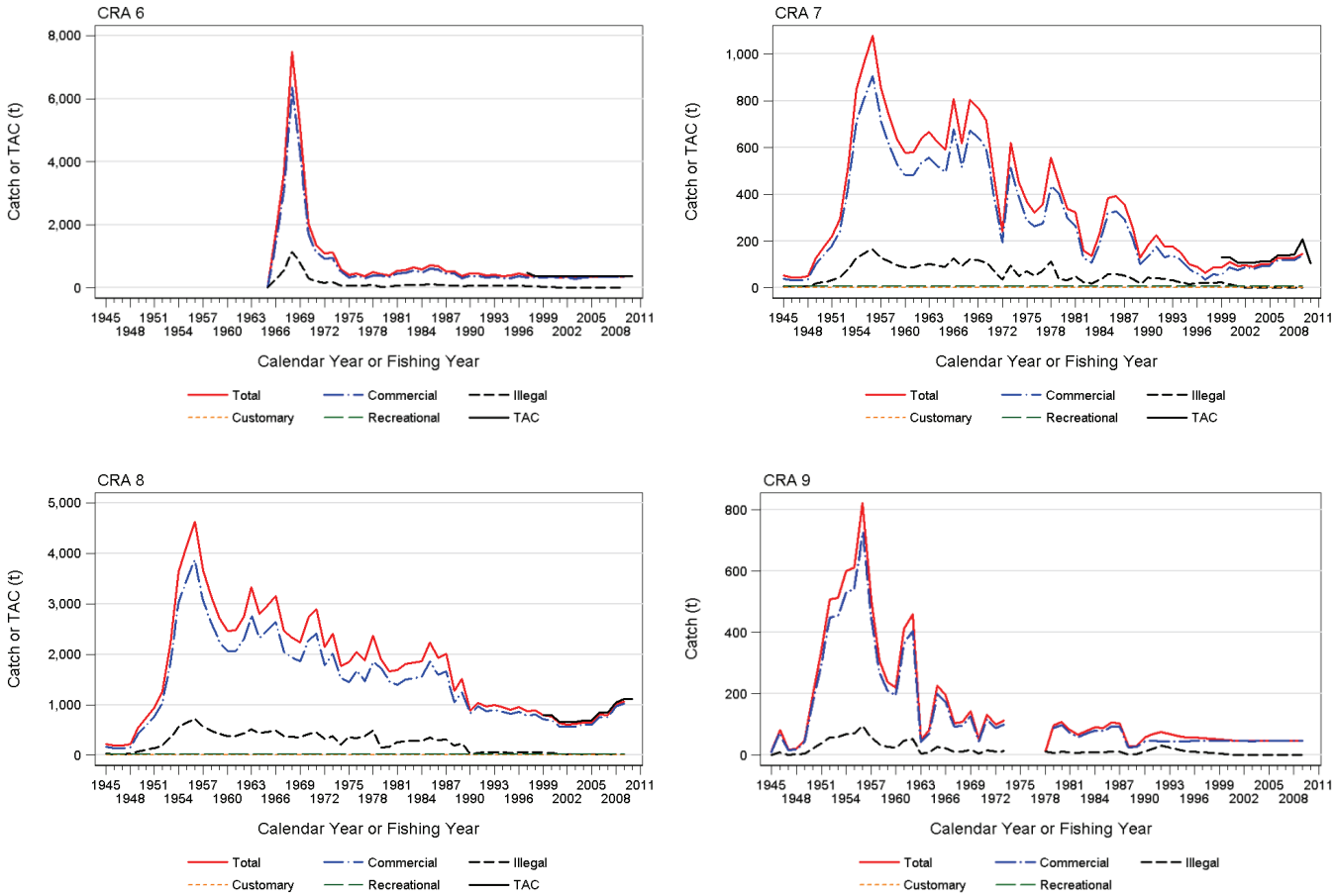


Figure 4 (cont.): Catch trajectories (t) from 1945 to 2010 for CRA 6 to CRA 9, showing current best estimates for commercial, recreational, customary and illegal categories. Also shown is the sum of these four catch categories and the TAC (t) if it exists. No catch estimates are available for CRA 9 from 1974 to 1978. Note that calendar year catches are plotted from 1945 to 1977. Statutory fishing years (1 April to 31 March) catches are plotted from 1979 on. Catches for 1978 are for 15 months, including January to March 1979.

2. BIOLOGY

Although lobsters cannot be easily aged in numbers sufficient for use in fishery assessments, they are thought to be relatively slow-growing and long-lived. *J. edwardsii* and *S. verreauxi* occur both in New Zealand and southern Australia. The following summary applies only to *J. edwardsii* in New Zealand.

Sexual maturity in females is reached from 34–77 mm TW (about 60–120 mm carapace length), depending on locality within New Zealand. For instance, in CRA 3, 50% maturity appears to be realised near 40 mm TW while most females in the south and south-east of the South Island do not breed before reaching MLS.

Mating takes place after moulting in autumn, and the eggs hatch in spring into the short-lived naupliosoma larvae. Most of the phyllosoma larval development takes place in oceanic waters tens to hundreds of kilometres offshore over at least 12 months. Near the edge of the continental shelf the final-stage phyllosoma metamorphoses into the settling stage, the puerulus. Puerulus settlement takes place mainly at depths less than 20 m, but not uniformly over time or between regions. Settlement indices measured on collectors can fluctuate widely from year to year.

Values used for some biological parameters in stock assessments are shown in Table 12.

Table 12: Values used for some biological parameters.

1. Natural mortality (*M*) [1]

Area	Both Sexes
CRA 1, 2 ,3, 4, 5	0.12
NSS	0.12

[1] This value has been used as the mean of an informative prior; *M* was estimated as a parameter of the model.

2. Fecundity = a TW^b (TW in mm) (Breen & Kendrick 1998)[2]

Area	*a*	*b*
NSN	0.21	2.95
CRA 4 & CRA 5	0.86	2.91
NSS	0.06	3.18

[2] Fecundity has not been used by post-1999 assessment models.

3. Weight = a TW^b (weight in kg, TW in mm) (Breen & Kendrick, Ministry of Fisheries unpublished data)

	Females		Males	
Area	***a***	***b***	***a***	***b***
CRA 1, 2, 3, 4, 5	1.30 E-05	2.5452	4.16 E-06	2.9354
NSS	1.04 E-05	2.6323	3.39 E-06	2.9665

Long-distance migrations of rock lobsters have been observed in some areas. During spring and early summer, variable proportions of usually small males and immature females move various distances against the current from the east and south coasts of the South Island towards Fiordland and south Westland.

Growth modelling

The primary source of information for growth is tag-recapture data. Lobsters have been caught, measured, tagged and released, then recaptured and re-measured at some later time (and in some instances re-released and re-recaptured later). Since 1998, statistical length-based models have been used to estimate the expected increment-at-size, which is represented stochastically by growth transition matrices for each sex. Growth increments-at-size are assumed to be normally distributed with means and variances determined from the growth model. The transition matrices contain the probabilities that a lobster will move into specific size bins given its initial size.

The growth model contains parameters for expected increment at 50 mm and 80 mm TW, a shape parameter (1 = linear), the c.v. of the increment for each sex, the minimum standard deviation and the observation error. This model is over-parameterised if all parameters are estimated, so the final two and sometimes three parameters are fixed.

Since 2006, the growth model applied to the tag-recapture data has been a continuous model – giving a predicted growth increment for any time at liberty greater than 30 days – whereas the older versions assumed specific moulting periods between which growth did not occur. For assessment models developed since 2006, tag-recapture records from lobsters at liberty for fewer than 30 days have been excluded. Other basic data grooming is performed, but the robust likelihood fitting procedure precludes the need for extensive grooming of outliers. Growth parameters are estimated simultaneously with other parameters of the assessment model in an integrated way, so that growth estimates might be affected by the size frequency and CPUE data as well as the tag-recapture data.

For CRA 5 , tag recapture data for the 2010 assessment were available from 1975–1985 and 1997–2007. Comparisons of the estimated CRA 5 growth rate based on tagging made in the the earlier period with the modern period did not reveal any major change in growth rate similar to that discovered for CRA 3 (Breen et al. 2009).

Settlement indices

Annual levels of puerulus settlement have been estimated since 1979 or later at sites in Gisborne, Castlepoint, Napier, Wellington, Kaikoura, Moeraki, Halfmoon Bay, Chalky Inlet and Jackson Head. Table 13 provides the standardised settlement indices from all sites except Chalky.

Table 13: Puerulus settlement indices. Source: J. Forman & A. McKenzie, NIWA. Blanks indicate that no sampling was done, whereas a zero indicates a lack of observed settlement.

Year	Gisborne	Napier	Castlepoint	Kaikoura	Moeraki	Halfmoon	Jackson
1979		0.80					
1980		1.43		0		0.55	
1981		1.93		1.50		2.66	
1982		0.94		0.04		0.12	
1983		1.17	1.42	1.20		1.43	
1984		0.39	1.37	0.35		0.12	
1985		0.18	0.88	0.49		0	
1986			0.51	0.15		0.03	
1987			1.70	1.71		0.51	
1988		1.42	0.99	0.76		0.07	
1989		1.02	1.52	1.26		0.17	
1990		1.08	0.94	0.42	0.25	0.14	
1991	1.46	2.18	1.96	8.36	0	0.27	
1992	2.09	2.30	2.45	9.73	0.05	0.20	
1993	1.78	1.82	1.51	4.88	0	0	
1994	2.79	1.37	0.95	1.31	0	0.36	
1995	1.09	1.02	0.90	1.54	0.04	0.10	
1996	1.01	1.62	1.31	1.15	0.37	0.10	
1997	1.05	1.24	1.15	2.43	0.24	0.17	
1998	1.46	1.06	1.70	3.19	0.22	0.08	
1999	0.10	0.28	0.34	2.14	0.05	0.08	0.84
2000	0.95	0.64	0.56	1.88	1.29	0.38	0.78
2001	1.14	1.36	0.77	0.70	0.84	0.55	0.93
2002	1.11	1.08	0.69	1.84	0.34	0.42	3.33
2003	2.24	1.25	0.77	7.87	2.59	1.12	1.72
2004	0.77	1.05	0.65	2.72	0.18	0.04	0.32
2005	2.48	1.22	1.18	3.54	0.05	0	3.99
2006	0.37	0.57	0.65	2.95	0.04	0.04	0.44
2007	0.30	1.00	0.90	1.99	0.02	0.14	0.49
2008	0.70	0.57	0.89	3.73	0.07	0.03	0.31

3. STOCKS AND AREAS

There is no evidence for genetic subdivision of lobster stocks within New Zealand based on biochemical genetic and mtDNA studies. The observed long-distance migrations in some areas and the long larval life probably result in genetic homogeneity among areas. Gene flow at some level probably occurs to New Zealand from populations in Australia (Chiswell et al. 2003).

Subdivision of the NSI stock on other than genetic grounds has been considered (Booth & Breen 1992; Bentley & Starr 2001). There are geographic discontinuities in the prevalence of antennal b]anding, size at onset of maturity in females, migratory behaviour, fishery catch and effort patterns, phyllosoma abundance patterns and puerulus settlement levels. These observations led to division of the NSI stock into three substocks (NSN, NSC, and NSS) for assessments in the 1990s. Cluster analysis based on similarities in CPUE trends between rock lobster statistical areas provided support for those stock definitions (Bentley & Starr 2001).

Although considered separately for stock assessment purposes, the CHI stock (CRA 6) also appears to be genetically the same as the NSI stock. It may depend upon the NSI stock as a source of recruitment, but changes in abundance within the CHI stock are unlikely to affect the NSI stock.

Sagmariasus verreauxi forms one stock centred in northern New Zealand, and may be genetically subdivided from populations of the same species in Australia.

4. DECISION RULES AND MANAGEMENT PROCEDURES

This section presents evaluations of the NSN and NSC rock lobster decision rules and the existing CRA 3, CRA 4, CRA 7 and CRA 8 management procedures for the 2011-12 fishing year, based on CPUE data extracted in November 2010 and standardised as described below.

The NSN and NSC decision rules are just that; they are not proper management procedures because they have not been simulation-tested and they do not specify catch limits. They were developed in 1994 and have been evaluated every year since then without being triggered. Proper operational management procedures have now been developed for all three substocks of the NSC. Once a management procedure is adopted for CRA 5, then the NSC decision rule will become obsolete. The NSN decision rule is currently the only formal monitoring for CRA 1 and CRA 2, because no assessments have been done in these QMAs since 2002.

4.1 Data preparation

Data were extracted, groomed with method "B4" (Bentley et al. 2005) and aggregated by fishing year, month, rock lobster statistical area and vessel. The standardisation procedure (Maunder & Starr 1995; Bentley et al. 2005) uses month, statistical area and year (or period for CRA 4) as explanatory variables. Each QMA analysis was done separately and all data were used except for coded vessel number 4548, which has been consistently dropped from the NSN analysis.

The NSN and NSC decision rules use annual standardised CPUE indices based on the fishing year. The decision rule comparisons for the NSN and NSC are based on the exponents of year coefficients calculated by the regression model, which uses ln(catch/potlifts) as the dependent variable and bases the test for a significant change on the calculated standard error for each coefficient. The coefficients in these regressions are calculated relative to the fishing year with the smallest standard error.

Management procedures for CRA 3, CRA 7 and CRA 8 use the annual standardised CPUE estimates, based on an "offset year" which is the AW season and the preceding SS season, whereas the statutory rock lobster fishing year comprises the SS season and the preceding AW season. The CRA 4 management procedure is based on the most recent AW season from an analysis where each AW or SS season is evaluated as an independent time step (Bentley et al. 2005).

Standardisation for the offset year management procedure analyses (CRA 3, CRA 7 and CRA 8) follows the suggestion of Francis (1999) and calculates "canonical" coefficients and standard errors for each year, which allows calculation of standard errors for every coefficient including the base year coefficient. Each standardised index is then scaled by the geometric mean of the simple arithmetic CPUE indices (using the summed annual catch divided by summed annual effort for each offset year). The geometric mean CPUE is preferred to the arithmetic mean because it is less affected by outliers than the arithmetic mean. This procedure scales the standardised indices to CPUE levels consistent with those observed by fishermen.

4.2 Decision Rules for NSN and NSC

The decision rule described by Breen *et al.* (1994) was modified by the National Rock Lobster Management Group (NRLMG) for the NSN and NSC substocks to allow consideration of TAC increases. The original decision rule required that a substock be assessed whenever a "standardised CPUE analysis" (Maunder & Starr 1995) showed CPUE for a given year to be significantly lower than the CPUE estimate for 1992–93. A year index is considered "significantly different" from the 1992–93 year index if their standard-error bars do not overlap.

NSN

The standardised CPUE for the NSN substock increased steadily between the 1992–93 and 1998–99 fishing years (Figure 5). There were four consecutive years of decrease between 1998–99 and 2002–03, but this trend reversed after 2003–04, increasing for the next four years to a minor peak in 2007–08. The index has now declined for two consecutive years. Under the NSN decision rule, the 2009–10 CPUE is significantly above the 1992–93 CPUE (Table 14).

Table 14: Decision rule indices for 1992–93 and 2009–10 fishing years (1 April to 31 March) for the NSN and NSC substocks. The index is the year effect from a standardised CPUE analysis using 1984–85 and 1982–83 as base years for the NSN and NSC respectively. The table also shows the upper and lower bounds, which are the index plus and minus one standard error respectively. The final column indicates the significance of change between the two years (* = significant increase), based on a comparison of the 2009–10 lower bound (bold) with the 1992–93 upper bound (grey boxes).

Substock	1992–93 Index	1992–93 Lower	1992–93 Upper	2009–10 Index	2009–10 Lower	2009–10 Upper	Result
NSN	0.968	0.936	1.001	1.571	**1.506**	1.639	*
NSC	0.395	0.388	0.403	0.972	**0.945**	1.001	*

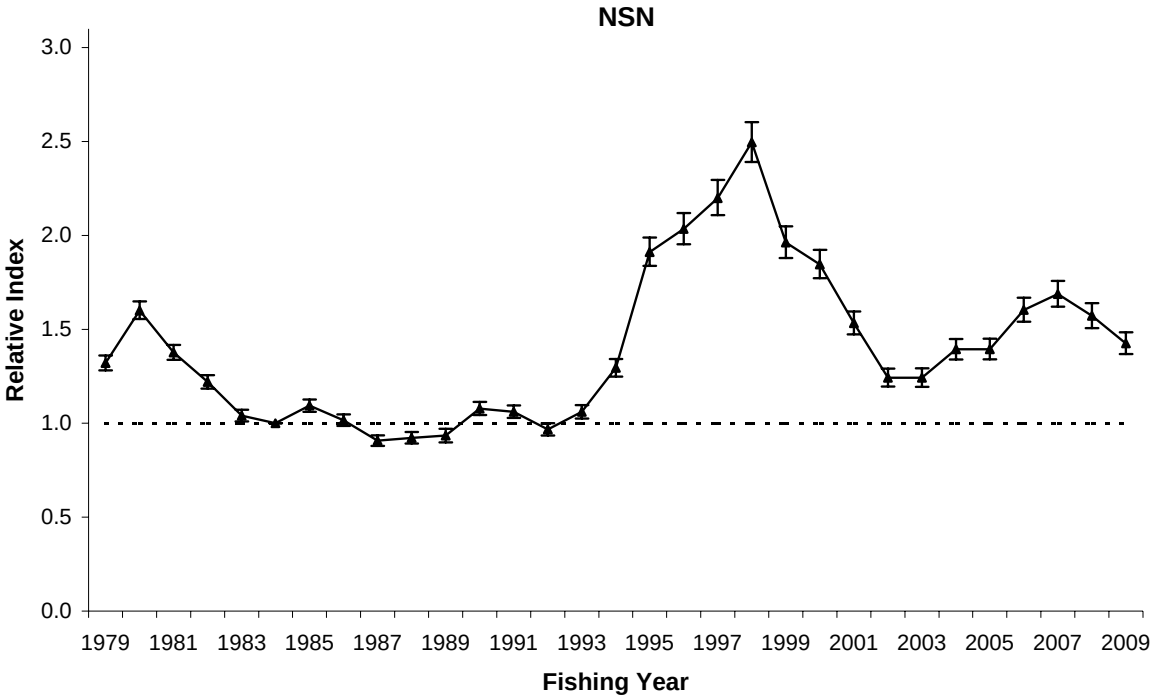


Figure 5: Values of the year index from the standardised CPUE analysis for the NSN substock showing plus and minus one standard error for each year. Horizontal line shows the index+ 1*S.E. upper bound of the 1992–93 standardised index (grey box: table 14), which is the threshold for triggering this decision rule. Each year index is relative to the 1984-85 fishing year (the year with the lowest standard error).

NSC

As in the NSN substock, standardised CPUE for the NSC substock increased steadily between the 1992–93 and 1998–99 fishing years (**Figure** 6). After reaching the 1998 peak, there was a continuous decline in CPUE to a level about 50% below the 1998–99 peak, reached in 2007–08. CPUE has recovered strongly in the two years since 2007–08. Under the decision rule, the 2009–10 CPUE is significantly above the 1992–93 CPUE (Table 14).

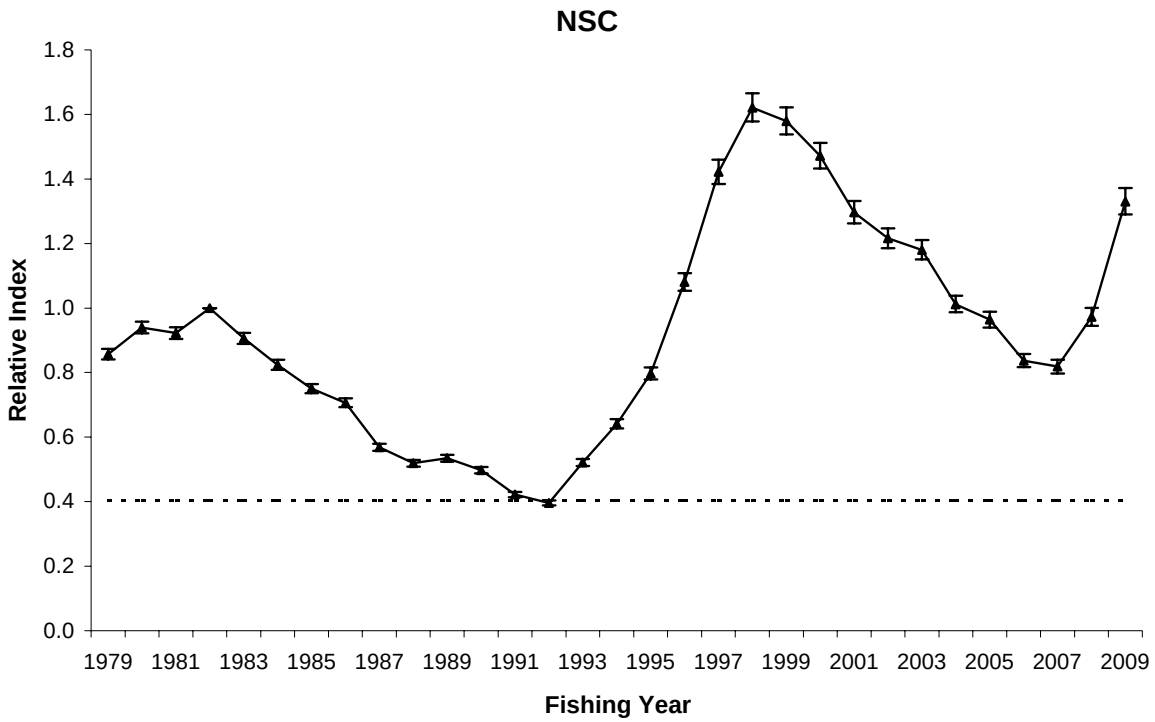


Figure 6: Values of the year index from the standardised CPUE analysis for the NSC substock showing plus and minus one standard error for each year. Horizontal line shows the index+ 1*S.E. upper bound of the 1992–93 standardised index (grey box: Table 14) which is the threshold for triggering this decision rule. Each year index is relative to the 1982–83 fishing year (the year with the lowest standard error).

4.3 Management Procedure for CRA 3

In 2009, an operating model based on the 2008 stock assessment model (Starr et al. 2009; Breen et al. 2009), updated with an additional year of catch and CPUE data, was used to develop a management procedure for CRA 3. Length frequency data were not updated, and all other model assumptions, modelling choices and inputs were unchanged. There had been no previous management procedure for this stock. After consideration of base case and robustness trial results, a small set of final candidates was presented to the statutory consultation round, and the Minister of Fisheries chose Rule 2a. This management procedure is specified as follows:

1. A conditional initial fixed TAC applies for 3 years (2010–11, 2011–12 and 2012–13) and is set at 293 tonnes, unless offset-year CPUE falls below 0.75 kg/potlift or increases above 1.08 kg/potlift. If the CPUE falls outside these limits, the initial TAC expires and the harvest control rule equations determine the TAC;

2. The conditional initial fixed TAC will expire after the 2012–13 fishing year and the harvest control rule equations will determine the TAC;

3. Offset-year standardised CPUE, calculated in November, will be used as input to the rule to determine the TAC for the statutory fishing year that begins in the following April;

4. The management procedure is to be evaluated every year (no “latent year”), based on offset-year CPUE;

5. The provisional TAC (before minimum and maximum change rules operate, and exclusive of considering the initial fixed TAC determined by the rule), is given by:

$$TAC'_{y+1} = 275\left(\frac{I_y + 3}{4}\right)^3 \qquad \text{for } 0 < I_y \le 1 \text{ and}$$

$$TAC'_{y+1} = 275\left(1 + \frac{0.5\left(I_y - 1\right)}{0.6}\right) \qquad \text{for } I_y > 1$$

where TAC'_{y+1} is the provisional TAC result from the rule and I_y is the input offset-year CPUE.

6. After the initial fixed TAC expires, if the procedure results in a TAC that does not change by more than 5%, no change will be made; and if the procedure results in a TAC that changes by more than 10%, the TAC will be changed by 10% only. The relation between CPUE and provisional TAC (before minimum and maximum change limits operate, and ignoring the initial fixed TAC) is illustrated in Figure 7.

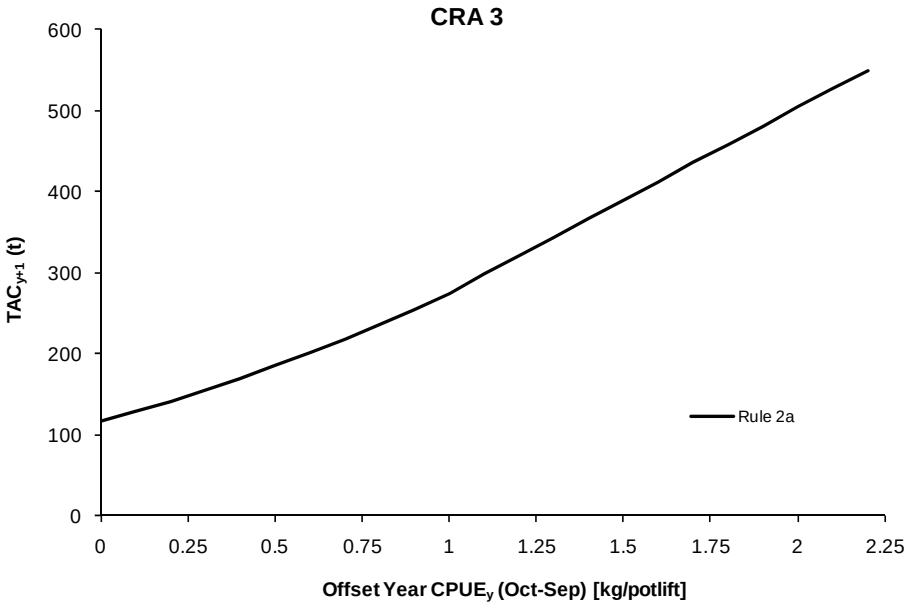


Figure 7: The CRA 3 management procedure, showing the provisional TAC as a function of CPUE.

The Minister of Fisheries accepted this rule in March 2010. The standardised offset-year CPUE for 2008–09 was 0.794 kg/pot. Because this was greater than the 0.75 kg/potlift threshold and less than the 1.08 kg/potlift threshold, the 2010–11 TAC remained at the conditional initial fixed TAC of 293 t. The TACC was determined by subtracting non-commercial allowances of 129 t, to obtain 164 t (15).

Table 15: History of the CRA 3 management procedure. "Rule result" is the result of the management procedure after operation of all its components including thresholds; '–': to be determined by the Minister

Year	Applied to fishing year	Offset-year CPUE (kg/potlift)	Rule result: TAC (t)	TACC (t)	TAC (t)
2009	2010–11	0.794	293	164	293
2010	2011–12 (proposed)	1.027	293	–	–

In November 2010, the standardised offset-year CPUE was 1.027 kg/potlift. Under the management procedure, the proposed TAC would remain at 293 t because the CPUE remains above the 0.75 kg/potlift threshold and below the 1.08 kg/potlift threshold.

4.4 Management Procedure for CRA 4

The most recent stock assessment for CRA 4, completed in 2005 (Breen et al. 2006), was used as the basis for an operating model that evaluated a large number of harvest control rules for this QMA (Breen & Kim 2006). This was done because the commercial fishery in this QMA was not catching the TACC and there was a need for a mechanism by means of which ACE (Annual Catch Entitlements) could be voluntarily removed from the fishery. This process of removal, known as "shelving", was used by the CRA 4 industry to set voluntary commercial catch limits for the 2007–08 and 2008–09 fishing years. This rule (rule E170) was adopted in March 2009 by the Minister of Fisheries. The rule (Figure 8) is specified as follows:

$$TACC'_{y+1} = 500\left(\frac{I_y}{0.9}\right)^{1.4}$$

where $TACC'_{y+1}$ is the provisional TACC result from the rule and I_y is CPUE from the most recent AW season. There is no latent year; the maximum allowable annual change in TACC is 75% and the minimum change is 5%.

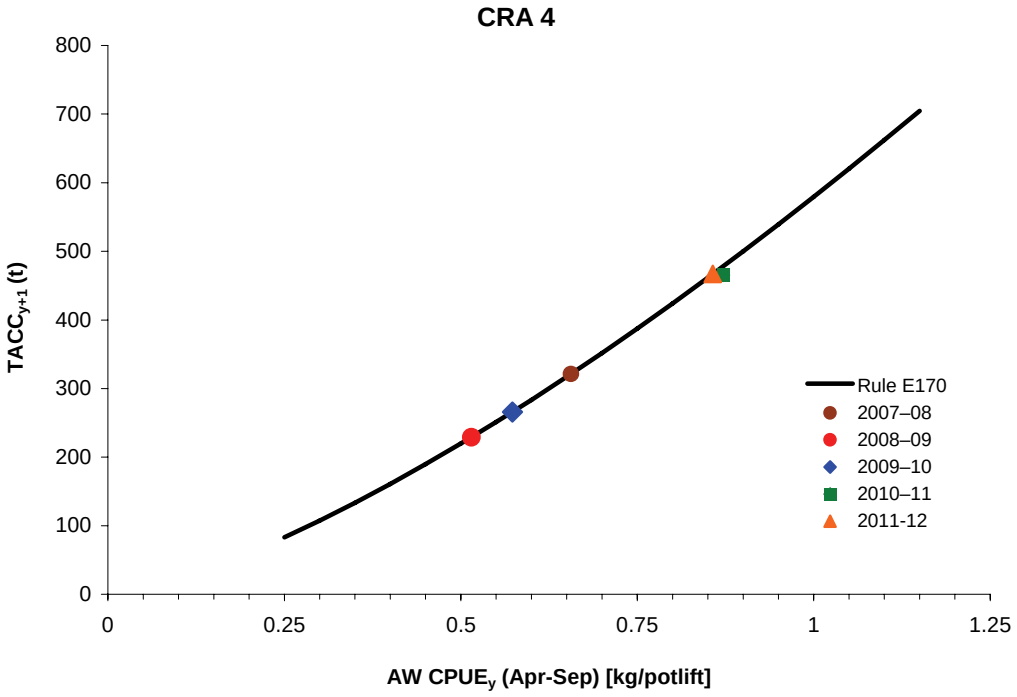


Figure 8: Graphic representation of the CRA 4 management procedure, plotting the catch limits in the next year as a function of CPUE in the current year and showing the CPUE values that generated the catch limit proposals for 2007–08, 2008–09, 2009–10, 2010–11 and 2011–12.

The history of the CRA 4 management procedure is shown in Table 16**Table**. For 2009–10, the Minister set the CRA 4 TACC to 266 t under the rule, resulting in a TAC of 461 t after adding allowances of 195 t for non-commercial fisheries. For 2010–11, the increased CPUE of 0.871 produced a provisional TACC result of 477.6 t, which was limited by the maximum change threshold of 75% to 465.5 t. The CRA 4 industry chose to "shelve" some of this increase, and the Minister set a TACC of 415.6 after the statutory consultation. The TAC was determined by adding non-commercial allowances of 195 t.

Table 16: History of the CRA 4 management procedure, showing proposed limits to the commercial fishery in each of three years. The "operational limit" shows the level of voluntary shelving achieved for the 2007–08 and 2008–09 fishing years. "Rule result" is the result of the management procedure after operation of all its components including thresholds; '–': to be determined by the Minister

Year	Applied to fishing year	AW CPUE (kg/potlift)	Rule result: TACC (t)	Operational limit (t)	TACC (t)	TAC (t)
2006	2007–08	0.656	321.1	339	577	771
2007	2008–09	0.515	228.9	240	577	771
2008	2009–10	0.573	265.9	266	266	461
2009	2010–11	0.871	465.5		415.6	610.6
2010	2011–12 (proposed)	0.857	466.9	–		–

The most recent AW standardised CPUE estimate for CRA 4 is 0.857 kg/pot for the period 1 April to 30 September 2010. Under the CRA 4 management procedure, the TACC would be 466.9 t.

4.5 Management Procedure for CRA 5

In 2010, a new management procedure was developed for CRA 5, using a 2010 stock assessment as the basis for an operating model (Haist et al. in prep). Elements of a voluntary ACE-shelving rule adopted by the CRA 5 industry in 2009 (Breen 2009) were incorporated into the proposed new management procedure. Note: a decision on the management procedure for this fishery had not been finalised when this report was completed (late November 2009).

4.6 Management Procedure for CRA 7

Since 1996, CRA 7 has been managed using management procedures, based on the observed CPUE in CRA 8 until 2007, then CPUE in CRA 7 since then. These have been revised over the years, most recently in 2007, when separate management procedures were accepted by the Minister of Fisheries for CRA 7 and CRA 8 for the 2008–09 fishing year.

The current management procedure uses the most recent offset-year standardised CPUE as input to generate a proposed TAC. There is no latent year; the minimum change threshold is 5% and the maximum change threshold is 50%.

The current harvest control rule for the CRA 7 management procedure gives provisional TAC as a simple function of CPUE. The rule is:

$$TAC'_{y+1} = 100 I_y$$

where TAC'_{y+1} is the rule's specified TAC for the next fishing year, before the operation of minimum and maximum change thresholds, and I_y is standardised CPUE from the most recent offset year.

The history of this rule is shown in Table 17. For 2010–11, the TAC change was limited by the 50% maximum change threshold. The operation of this rule for 2011–12 using the 2009–10 offset-year CPUE results in a TAC of 95.7 t (Figure 9).

Table 17: History of the current CRA 7 management procedure, showing proposed limits to the commercial fishery in each of four years. "Rule result" is the result of the management procedure after operation of all its components including thresholds; '–': to be determined by the Minister

Year	Applied to fishing year	Offset-year CPUE (kg/potlift)	Rule result: TAC (t)	TACC (t)	TAC (t)
2007	2008–09	1.439	143.9	123.9	143.9
2008	2009–10	2.09	209.0	189.0	209.0
2009	2010–11	0.803	104.5	84.5	104.5
2010	2011–12 (proposed under current MP)	0.957	95.7	–	–-

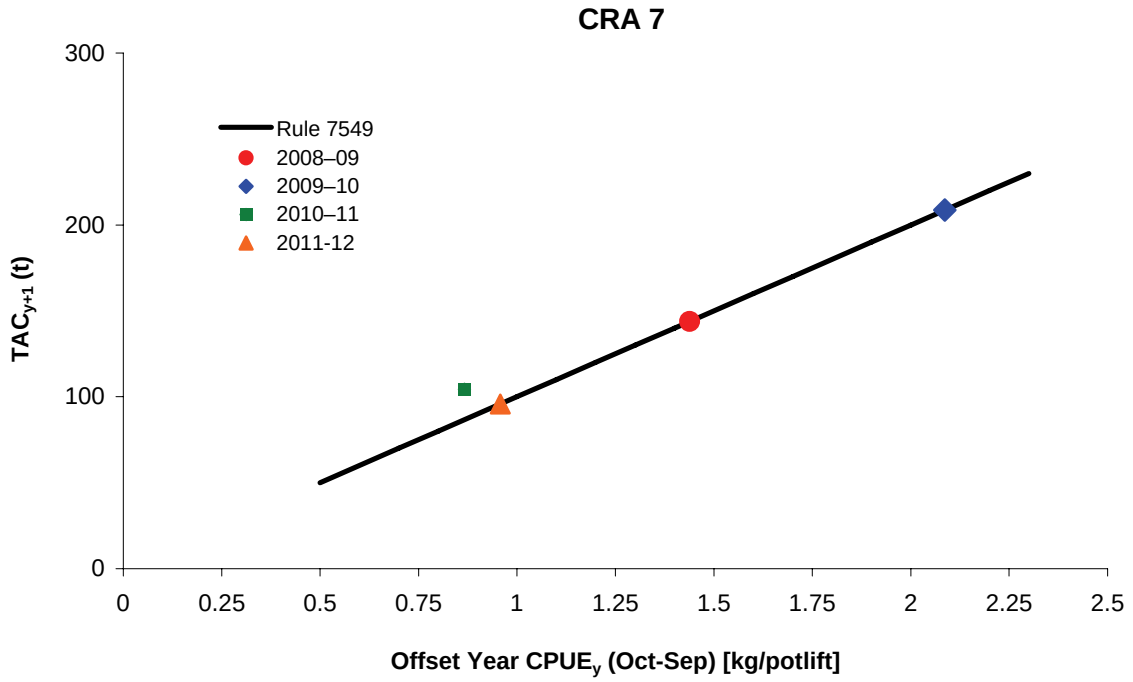


Figure 9: Graphic representation of the current CRA 7 management procedure, plotting the catch limits in the next year as a function of CPUE in the current year and showing the CPUE values which generated the limit proposals for 2008–09, 2009–10, 2010–11 and 2011–12.

In 2010, the CRA 7 industry requested exploration of a revised management procedure to reduce the apparent volatility of TACC. Note: any decision to chnage the management procedure for this fishery had not been finalised when this report was completed (late November 2009).

4.6 Management Procedure for CRA 8

CRA 8 has been managed since 1996 using management procedures based on the observed CPUE in the fishery. These have been revised several times, most recently in 2007, when separate management procedures were accepted by the Minister of Fisheries for CRA 7 and CRA 8 for the 2008–09 fishing year. The current management procedure uses the most recent offset-year standardised CPUE as input to generate a proposed TAC in every year. There is no latent year; the minimum change threshold is 5% and the maximum change threshold is 50%.

The harvest control rule driving the CRA 8 management procedure is shown in Figure 10. TAC is constant over a wide range of CPUE; decreasing at a faster rate than CPUE when CPUE is below a threshold (1.9 kg/potlift) and increasing more slowly when CPUE is above a threshold (3.2 kg/potlift). The plateau affords stability of TACC, a performance quality requested by the CRA 8 commercial industry.

Formally, this rule is given by:

$$TAC'_{y+1} = \begin{cases} \max\left(0, \left(1053 - 1.2\left(1.9 - I_y\right)\dfrac{1053}{1.9}\right)\right), & I_y < 1.9, \\ 1053, & 1.9 \le I_y \le 3.2, \\ 1053 + 0.16\left(I_y - 3.2\right)\dfrac{1053}{1.9}, & I_y > 3.2. \end{cases}$$

where TAC'_{y+1} is the rule's specified TAC for the next fishing year, before the operation of minimum and maximum change thresholds, and I_y is standardised CPUE from the most recent offset year.

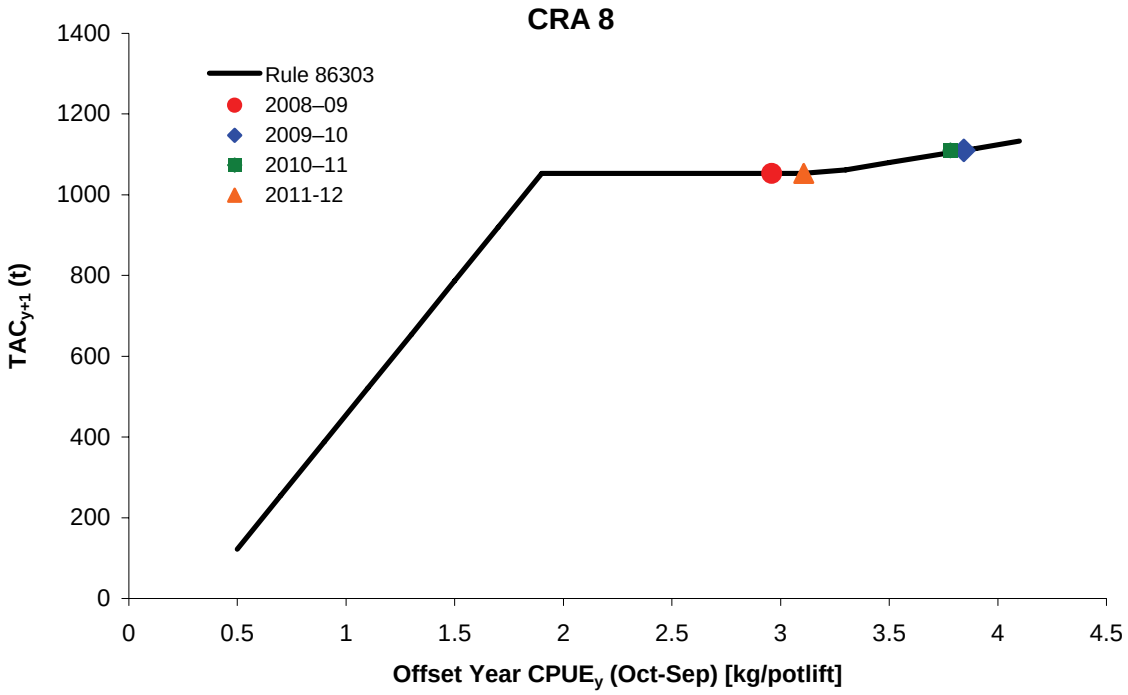


Figure 10: Graphic representation of the CRA 8 management procedure, plotting the TAC in the next year as a function of offset-year CPUE in the current year and showing the CPUE values which generated the TAC proposals for 2008–09, 2009–10, 2010–11 and 2011-12.

The history of the current CRA 8 management procedure is shown in Table 18. In 2009, the offset-year CPUE gave a provisional TAC that was a small decrease, but the decrease was less than the minimum change threshold of 5%, so no change was made.

Table 18: History of the CRA 8 management procedure, showing proposed limits to the commercial fishery in each of four years. "Rule result" is the result of the management procedure after operation of all its components including thresholds; '–': to be determined by the Minister

Year	Applied to fishing year	Offset-year CPUE (kg/potlift)	Rule result: TAC (t)	TACC (t)	TAC (t)
2007	2008–09	2.960	1053	966	1053
2008	2009–10	3.844	1110	1019	1110
2009	2010–11	3.781	1110	1019	1110
2010	2011–12 (proposed)	3.107	1053	–	–

The most recent annual standardised CPUE estimate for CRA 8 is 3.107 kg/pot for the period 1 October 2009 to 30 September 2010. Under the CRA 8 management procedure, the TAC would be 1053 t.

5. ENVIRONMENTAL EFFECTS OF FISHING

This section is new for the November 2010 Plenary after review by the Aquatic Environment Working Group. This summary is from the perspective of the rock lobster fisheries; a more detailed summary from an issue-by issue perspective will be available in the Ministry's Aquatic Environment Plenary that is under development.

The environmental effects of rocl lobster fishing has been covered more extensively by Breen (2005) and only those issues deemed most important there, or of particular relevance to fisheries management are covered here.

5.1 Role in the ecosystem

Rock lobsters are predominantly nocturnal (Williams and Dean 1989). Their diet is reported to be comprised primarily of molluscs and other invertebrates (Booth 1986; Andrew and Francis 2003). Survey and experimental work has shown that predation by rock lobsters in marine reserves is capable of influencing the demography of surf clams of the genus *Dosinia* (Langlois, Anderson et al. 2005; Langlois, Anderson et al. 2006).

Predation by rock lobsters has been implicated in contributing to trophic cascades in a number of studies in New Zealand and overseas (Mann and Breen 1972; Babcock, Kelly *et al.* 1999; Edgar and Barrett 1999). For example, in Leigh marine reserve rock lobsters and snapper preyed on urchins, the densities of urchins decreased and kelp beds re-established in the absence of urchin grazing (Shears and Babcock 2003). This implies that rock lobster fishing is one of a number of factors that may alter the ecosystem from one more dominated by kelp beds to one more dominated by urchin barrens. Trophic cascades are hard to demonstrate however, as controlled experiments are difficult, food webs are complex and environmental factors are changeable (Breen 2005).

Published scientific observations support predation upon rock lobsters by octopus (Brock *et al.* 2003), blue cod, groper, southern dogfish (Pike 1969) and seals (Yaldwyn 1958, cited in Kensler 1967). Anecdotal information supports predation upon rock lobsters by. rig (M. Francis *pers. comm.*).

5.2 Incidental catch (fish and invertebrates)

The levels of incidental catch landed from rock lobster potting were analysed for the period from 1989 to 2003 (Table 26, Bentley *et al.* 2005). Non- rock lobster catch landed ranged from 2 to 11 percent of the estimated rock lobster catch weight per QMA over this period. These percentages are based on estimated catches only and it is likely that not all bycatch is reported (only the top five species are requested) and that the quality of the weight estimates will vary between species There were 129 species recorded landed from lobster pots over this period. The most frequently reported incidental species caught (comprising on average greater than 99% of the bycatch per QMA) were, in decreasing order of catch across all stocks: octopus, conger eel, blue cod, trumpeter, sea perch, red cod, butterfish and leatherjackets.

5.3 Incidental catch (seabirds and mammals)

Recovery of shags from lobster pots has been documented. One black shag (*Phalacrcorax carbo*) of 41 recovered dead from a Wairarapa banding study was found drowned in a crayfish pot hauled up from 12m depth (Sim and Powlesland 1995). Two Pitt Island shags (*Stictocarbo featherstoni*) were also recovered dead from lobster pots on a Chatham Island crayfish boat for 6 months from October 1997 to March 1998 (Bell and Bell 2000).

From January 2000 to August 2010, there were nine entanglements of eight humpback whales attributed to commercial or recreational rock lobster pots from the area within CRA5 from the Conway River north to Mangamaunu, which includes the Kaikoura Peninsula (DoC Unpublished report to Te Korowai, September 2010). No mortalities were observed, although mortalities are likely to be caused by prolonged entanglement, and therefore might not be observed within the same area. CRA 5 commercial fishermen work to a voluntary code of practice to avoid entanglements; this is awaiting endorsement from the Department of Conservation and Te Korowai. The commercial fishermen also cooperate with the Department of Conservation to assist releases when entanglements do occur.

5.4 Benthic interactions

Potting is the main method of targeting rock lobster and is usually assumed to have very little direct impact on non-target species. No information exists regarding the benthic impacts of potting in New Zealand.

A study on the impacts of lobster pots was completed in a report on the South Australian rock lobster fisheries (Casement and Svane 1999). This fishery is likely to be the most comparable to New Zealand as the same species of rock lobster is harvested and many of the same species are present,

although the details of pots and how they are fished may differ. The report concluded that the mass of algae removed in pots probably has no ecological significance.

Two other studies provide results from other parts of the world, but the comparability of these studies to New Zealand is questionable given differences in species and fishing techniques. The Western Australia Fishery Department calculated the proportion of corals (the most sensitive fauna) likely to be impacted by potting and concluded they were low; i.e. between 0.1 and 0.3% per annum (Department of Fisheries Western Australia 2007). This kind of calculation for the New Zealand fishery would require better habitat maps than currently exist for most parts of the coast (Breen 2005) as well as finer scale catch information than the Ministry currently possesses. Direct effects of potting on the benthos have been studied in Great Britain (Eno *et al.* 2001) and 4 weeks of intensive potting resulted in no significant effects on any of the rocky-reef fauna quantified. Observations in this paper indicated sea pens were bent (but not damaged) and one species of coral was damaged by pots.

The only regulatory limitation on where lobster pots can be used is inside marine reserve boundaries; however, in Fiordland four areas within marine reserves have been designated for commercial pot storage due to the shortage of suitable space (Fiordland Marine Guardians 2008). Likewise, in the Taputeranga marine reserve (Wellington) an area is designated for vessel mooring and the storage of 'holding pots' by commercial fishermen.

5.5 Other considerations

There is no published information concerning ghost fishing by rock lobster pots in New Zealand, although since 1993 using pots with escape gaps has been compulsory in order to lessen the impact of potential ghost fishing. Ghost fishing occurs when lost gear continues to catch and kill animals.

Variable results have been seen with ghost fishing experiments internationally using lobster pots and, given differences in fishing techniques and species involved, the application of these studies to New Zealand is questionable. The loss to the fishery from retention or cannibalism in unbaited traps was estimated at a third or more of lobsters in or entering pots in a Maine study (Sheldon and Dow 1975). Contrastingly, lobster mortality was estimated at a maximum of 4% of entry into unbaited pots in Hawaii (Parrish and Kazama 1992). A study of ghost fishing of baited creels for Norway lobster concluded that once the initial bait was consumed, escape of captured lobsters was high and lost creels would cease to fish (Adey *et al*. 2008).

No habitats of particular significance to fisheries management have been defined for this fishery. An area near North Cape is, however, currently closed to packhorse lobster fishing to mitigate sub-legal handling disturbance in this area. This closure was generated due to the smaller sizes of animals there and results from a tagging study that showed movement away from this area into nearby fished areas (Booth 1979).

6. STOCK ASSESSMENT

A new stock assessment was completed in 2010 for CRA 5. This section also reports stock assessment results for other stocks from earlier Mid-Year Plenary documents. The text has not been updated from the original and reflects the TAC, TACC and allowances that were current at the time each assessment was completed.

6.1 CRA 1 and CRA 2

This section reports assessments for *J. edwardsii* for CRA 1 and CRA 2 from the NSN substock taken from the 2002 Mid-year Plenary report (Sullivan & O'Brien 2002).

Model structure

The size-based model used in 2001, which was fully described by Breen et al. (2002), has been revised and improved for the 2002 assessment. The model is fitted to two series of catch rate indices from different periods, to size frequency and tagging data. There are no settlement data for the NSN stock.

An important structural feature of the model is the division of the year into two seasons (autumn-winter: April to September, and spring-summer: October to March). This captures more accurately several biological processes: a) season- and sex-specific moult patterns; b) possible differential vulnerability of both sexes between each other and between the two seasons; and c) a reduction in the vulnerability of mature females in the autumn-winter season because of their egg-bearing status. The seasonal structure is important to incorporate because several fisheries have changed from predominantly spring/summer fisheries to autumn/winter fisheries which catch mostly male lobsters.

Significant catches occurred in the early part of the time series for CRA 1 and CRA 2. Different regulations existed at this time and pots were not required to have escape gaps. We therefore incorporated historical information for CRA 1 and CRA 2: a time series of sex-specific MLS regulations, time series of catch per day estimates for the 1960s and early 1970s, and some early size frequency data, including market sampling data. These data and their sources are listed in Table 19. It was possible to estimate recruitment deviations beginning in 1960.

Major changes made to the 2002 model were:

- The CV of the expected growth increment was changed to a sex-specific parameter.
- The catch dynamics were changed to operate in two parts during each 6-month period so that proportions-at-length could be calculated from the mid-season length structure. The dynamics of the SL and NSL fisheries (fisheries respecting or not respecting the size limit) were both improved by doing this.

The initial population in 1945 is assumed to be in equilibrium with average recruitment and with no fishing mortality. Each season the number of male, immature female and mature female lobsters within each size class is updated as a result of:

a) **Recruitment**. Each year, new recruits are added equally for each sex and both seasons, into the smallest size classes, beginning with the autumn-winter season. The proportion of individuals entering each size class is modelled as a normal distribution with a mean size (32 mm) and standard deviation (2 mm), and is truncated at the smallest size class (30 mm). The magnitude of recruitment in a specific year is determined by the parameter for base recruitment and (except for the early years) a parameter representing the deviation from base recruitment. The vector of recruitment deviations is assumed to be normally distributed with a mean of zero. The years for which recruitment deviations were estimated were 1960 to 2001.

b) **Mortality**. Natural, fishing and handling mortalities are applied to each sex category (male, immature female and mature female) in each size class. Natural mortality is estimated, but assumed to be constant and independent of sex category and length. Fishing mortality is determined from observed catch and model biomass, modified by legal sizes, sex-specific vulnerabilities and selectivity curves. Fisheries that respect size limits (SL fisheries – legal commercial and recreational) are differentiated from those which do not (NSL fisheries – part of the illegal fishery plus the Mäori traditional fishery). It is assumed that size limits and the prohibition of taking of berried females apply only to the SL fisheries. Otherwise, the selectivity and vulnerability functions are the same for the SL and NSL fisheries. Relative vulnerability is calculated by assuming that the males in the spring-summer season have the highest vulnerability and that the vulnerability of all other sex categories by season are equal to or less than the spring-summer males. Mature females have no legal vulnerability in the autumn-winter, when all are assumed to be ovigerous. The annual rate of SL fishing mortality is calculated as the ratio of catch to the SL biomass, where catch includes both the legal catch and the portion of NSL catch taken from the SL biomass. SL biomass is defined as the weight of males and females in the size classes above the MLS limits, adjusted for their relative vulnerability as defined above. Handling mortality rate is assumed to be proportional to legal fishing mortality at 10% of all lobsters that are released.

c) **Fishery selectivity curves**. A three-parameter fishery selectivity function is assumed, with parameters describing increasing vulnerability from the initial size class to a maximum, followed by decreasing vulnerability. The three parameters describe the shapes of the ascending and descending limbs and the size at which vulnerability is maximum. Changes in regulation over time (for instance, changes in escape gap regulations) can be modelled by estimating separate

selectivity parameters appropriate to each period of the fishery (but in these assessments, only one selectivity period was estimated in the base cases).

d) **Growth and maturity**. For each size class and sex category in a season, a transition matrix specifies the probability of an individual remaining in the same size class or growing into each of the other size classes. Maturity for females is estimated as a two-parameter logistic curve from the maturity-at-size information in the size frequency data.

Model fitting

A total negative log likelihood function was minimised using AD Model Builder™. The model was fitted to standardised CPUE indices estimated by season from the 1979–80 to 2001–02 fishing years. The model was also fitted to an additional seasonal catch rate index based on daily catch and effort data for the period 1963 to 1973 (Annala & King 1983). A lognormal error structure was assumed and a catchability constant (q) was calculated analytically for each CPUE series.

The model was fitted to size data taken from commercial pots. These data were available either from research sampling conducted on commercial vessels or from voluntary logbooks maintained by rock lobster fishers in CRA 1 and CRA 2. Estimates of the seasonal size frequency were obtained by collating data that had been summarised by area/month strata and weighted by the commercial catch taken in each stratum, the number of lobsters measured and the number of days sampled. Size data from each source (research sampling or voluntary logbooks) were fitted separately. A fundamental assumption is that the size frequency data are representative of the commercial lobster catch. The size proportions within each season summed to one across all three sex categories: males, immature females, and mature females. This provides the model with seasonal estimates of the relative proportion by sex category in the catch.

Market sampling data were also used in the fitting procedure. These data are available only as carapace lengths from males and females, without maturity information. The carapace lengths were converted to tail width, and the model made predictions for the size classes beginning at one size class above the MLS.

A summary of the data used in each assessment, the data sources and the applicable years are provided in Table 19.

Table 19: Data types and sources for the 2002 assessment s for CRA 1 and CRA 2. Year codes apply to the first 9 months of each fishing year, viz. 1998–99 is called 1998. NA – not applicable or not used; MFish - NZ Ministry of Fisheries; NZRLIC – Rock Lobster Industry Council.

Data type	Data source	Begin year	End year
Historical catch rate	Annala & King (1983)	1963	1973
CPUE	FSU & CELR	1979	2002
Historical proportions-at-size	Various	1974	1978
Observer proportions-at-size	MFish	1990	2002
Logbook proportions-at-size	NZRLIC	1993	2002
Historical tag recovery data	MFish various	1975	1986
Current tag recovery data	NZRLIC & MFish	1996	2002
Historical MLS regulations	Annala (1983)	1945	2002
Escape gap regulation changes	Annala (1983)	1945	2002

The parameters estimated in each model and the priors used are provided in (Table 2 **Table** 0). Fixed parameters and their values are given in (Table 3Table). CPUE, the historical catch rate, the priors and the tagging data were weighted directly by a relative weighting factor. For CRA 1, we varied the weights to obtain standard deviations of standardised residuals for each data set that were close to one. For CRA 2 it was necessary to further increase the weight on CPUE data to obtain a credible fit.

Table 20: Parameters estimated and priors used in basecase assessments for CRA 1 and CRA 2. Prior type abbreviations: U – uniform; N – normal; L – lognormal.

	Prior Type	Bounds	Mean	CV
Log R_0 (ln mean recruitment)	U	1–50	–	–
M (natural mortality)	L	0.01–0.35	0.12	0.4
Recruitment deviations	N [1]	-2.3–2.3	0	0.4
Increment at TW=50 (male & female)	U	1–8	–	–
Increment at TW=80 (male & female)	U	-10–3	–	–
CV of growth increment (male & female)	U	0.01–1.0	–	–
Minimum standard deviation of growth	U	0.01–5.0	–	–
TW at 50% probability female maturity	U	30–80	–	–
(TW at 95% probability female maturity) – (TW at 50% probability female maturity)	U	0–60	–	–
Relative vulnerability: males autumn-winter [2]	U	0–1	–	–
Relative vulnerability: immature females autumn-winter	U	0–1	–	–
Relative vulnerability: immature and mature females spring-summer	U	0–1	–	–
Relative vulnerability: mature females autumn-winter	U	0–1	–	–
Shape of ascending limb of vulnerability ogive	U	1–50	–	–
Size at maximum selectivity males	N	10–80	54	2.0
Size at maximum selectivity females	N	10–80	60	2.0
Variance of descending limb of vulnerability ogive (males & females)[3]	U	1–250	–	–

[1] Normal in logspace = lognormal (bounds equivalent to –10 to 10)
[2] Relative vulnerability of males in spring-summer was fixed at one
[3] Fixed at 200 in basecase assessment.

Table 21: Fixed parameter values used in basecase assessment for CRA 1 and CRA 2.

	CRA 1	CRA 2
Std dev of observation error of increment	2	2
Historical catch per day CV	0.30	0.30
Maximum exploitation rate	90%	90%
Current male size limit	54	54
Current female size limit	60	60
First year for recruitment deviations	1960	1960
Last year for recruitment deviations	2001	2001
Relative weight for length frequencies	50	18
Relative weight for CPUE	1	2
Relative weight for CR	0.6	1
Relative weight for tag-recapture data	0.5	1

Model projections

Bayesian estimation procedures were used to estimate uncertainty in model estimates of current biomass, and in future projections. This procedure was conducted in the following steps:

a) Model parameters were estimated using maximum likelihood and the prior probabilities. These point estimates represent the mode of the joint posterior distributions of the parameters, and are called the MPD estimates;

b) Samples from the joint posterior distribution of parameters were generated using the Markov chain – Monte Carlo procedure (MCMC) using the Hastings-Metropolis algorithm;

c) For each sample of the posterior, 5-year projections (encompassing the 2002–03 to 2006–07 fishing years) were generated by assuming the catches indicated in Table 22. Future annual recruitment was randomly sampled with replacement from the model's estimated recruitments from the period 1989–1998;

d) A marginal posterior distribution was found for each quantity of interest by integrating the product of the likelihood and the priors over all model parameters; the posterior distribution was described by the mean, median, and 5th and 95th percentiles.

Table 22: Catches (t) used in the five-year projections. Projected catches are based on the current TACC for CRA 1 and CRA 2, and the current estimates of recreational, customary and illegal catches.

Population modelled	Commercial	Recreational	Reported Illegal	Unreported Illegal	Customary
CRA 1	129.2	47.2	0	72	10
CRA 2	225.0	122.6	5	83	10

Performance indicators

The 2001 Plenary agreed to use a number of performance indicators as measures of the stock status for CRA 1 and CRA 2. These performance indicators were calculated using the current catch levels. The RLFAWG did not consider that virgin biomass or B_{MSY} were appropriate reference points, given the difficulty of accurately estimating these quantities. Therefore the assessment used performance indicators based on biomass levels for the ten years 1979 to 1988. This is the earliest period for which we have CPUE data and base case fits for both CRA 1 and CRA 2 suggested that biomass was relatively stable during this period. The Plenary agreed that this was an appropriate reference biomass level. Biomass in both stocks increased in the mid 1990s to higher levels than this reference level.

1. $BVULN_{02}/BVULN_{79–88}$
2. $BVULN_{07}/BVULN_{02}$
3. $BVULN_{07}/BVULN_{79–88}$
4. $UNSL_{02,AW}$
5. $USL_{02,AW}$
6. $UNSL_{06,AW}$
7. $USL_{06,AW}$

The vulnerable biomass in the assessment model is determined by four factors:

- MLS for male and female lobsters
- Length-based selectivity function
- Relative seasonal vulnerability of males and mature and immature females (parameters of the model)
- Berried state for mature females

Current vulnerable biomass, $BVULN_{02}$, is defined as the beginning season vulnerable biomass on 1 April 2002, the beginning of the autumn-winter season for the 2002–03 fishing season. Similarly, projected vulnerable biomass $BVULN_{07}$ is defined as the beginning season vulnerable biomass on 1 April 2007, the beginning of the autumn-winter season for the 2007–2008 fishing season. Vulnerable biomass was also calculated for the reference period: $BVULN_{79–88}$ is defined as the mean of beginning AW vulnerable biomass from 1979 through 1988.

$USL_{02,AW}$ is the exploitation rate for catch taken from the SL vulnerable biomass in the autumn-winter season of 2002–03, and $USL_{06,AW}$ is the exploitation rate for catch taken from the SL vulnerable biomass in the autumn-winter season of 2006–07, the last year of projections. $UNSL_{02,AW}$ and $UNSL_{06,AW}$ are similarly defined except that they describe the exploitation rate for catch taken from the NSL vulnerable biomass.

Stock assessment results: Jasus edwardsii, CRA 1

The base case assessment for CRA 1 was obtained by making the standard deviations of standardised residuals from all data sets close to 1 by adjusting the relative weights for each data set. The fit to the data was acceptable, with some systematic problems in fitting the seasonal pattern of CPUE and some large residuals in the fits to proportions-at-length, perhaps caused by the poor quality of these data.

Base case results suggested that biomass decreased to a low point in 1973, increased through the early 1980s, declined again until the early 1990s (but not as low as in 1973), increased strongly in the late 1990s and then declined slightly (Figure 11). Exploitation rate peaked in the early 1970s near 30% for the spring-summer fishery, and are currently in the 7–12% range.

A series of sensitivity trials suggested that the results were robust to these trials (based on MPD estimates), except that when the relative weight for CPUE was doubled, the model estimated a high *M* and very high biomass. A set of retrospective analyses on the MPD fits showed little effect of removing data one year at a time, beginning with the most recent year of data.

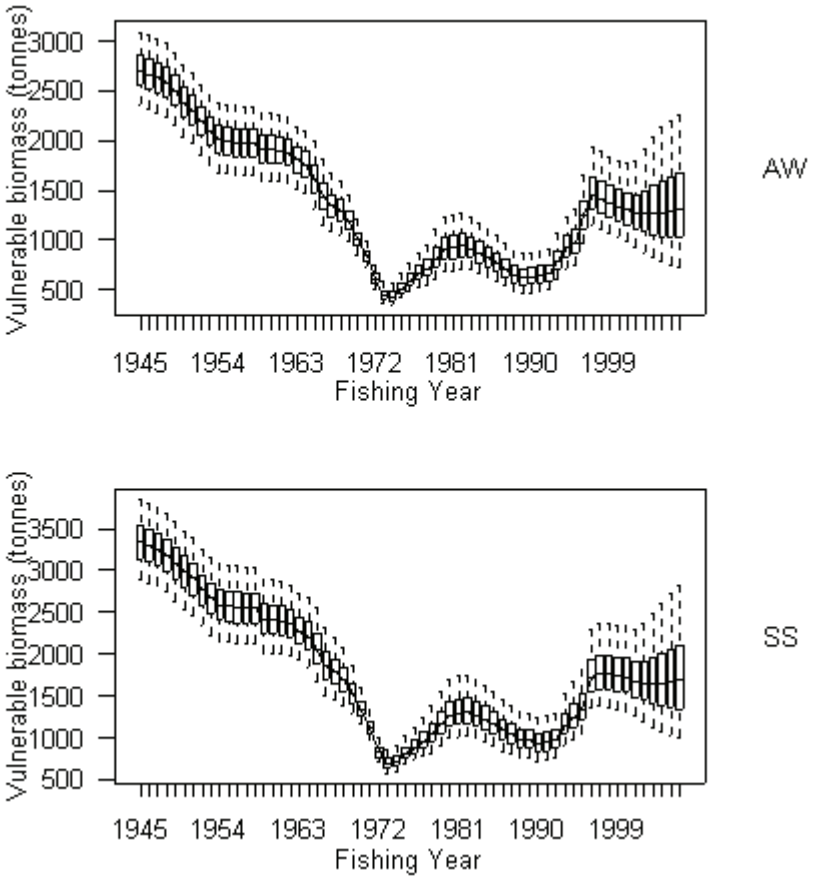


Figure 11: CRA 1: posterior trajectories of vulnerable biomass, for the AW (top) and SS (bottom) seasons, from the CRA 1 base case MCMC simulations. For each year the horizontal line represents the median, the box spans the 25th and 75th percentiles and the dashed whiskers span the 5th and 95th percentiles.

Table 23: Summary statistics for performance indicators from posterior distributions from CRA 1. Biomass indicators are shown in t.

			Basecase			Estimate male SS vulnerability				Estimate descending limb variance of vulnerability ogive		
Indicator	0.05	median	mean	0.95	0.05	median	mean	0.95	0.05	median	mean	0.95
$BALL_{79–88}$	1 741	2 057	2 091	2 542	1 618	1 903	1 949	2 414	2 014	2 560	2 638	3 534
$BRECT_{79–88}$	1 029	1 278	1 304	1 652	959	1 190	1 218	1 570	1 307	1 775	1 832	2 558
$BVULN_{79–88}$	642	834	852	1 121	593	768	793	1 071	623	821	845	1 153
$BALL_{02}$	2 274	2 995	3 082	4 155	2 159	2 788	2 880	3 905	2 894	3 981	4 131	5 844
$BRECT_{02}$	1 594	2 050	2 089	2 715	1 514	1 932	1 980	2 619	2 144	2 961	3 067	4 311
$BVULN_{02}$	929	1 276	1 308	1 792	859	1 182	1 221	1 720	891	1 227	1 272	1 798
$BALL_{07}$	2 007	3 113	3 209	4 771	1 840	2 868	2 969	4 448	2 686	4 208	4 361	6 643
$BRECT_{07}$	1 268	2 087	2 170	3 355	1 172	1 944	2 025	3 171	1 877	3 099	3 231	5 040
$BVULN_{07}$	725	1 320	1 382	2 269	646	1 204	1 266	2 123	768	1 305	1 379	2 242
$UNSL_{02}$ (%)	1.7	2.5	2.5	3.3	1.8	2.6	2.7	3.5	1.7	2.4	2.4	3.3
USL_{02} (%)	7.4	10.4	10.6	14.3	7.8	11.2	11.4	15.4	7.3	10.7	10.8	14.7
$UNSL_{06}$ (%)	1.5	2.4	2.5	3.8	1.6	2.6	2.7	4.2	1.4	2.3	2.4	3.6
USL_{06} (%)	6.2	10.3	10.9	17.4	6.6	11.3	11.9	19.3	6.2	10.3	10.8	16.8
$BVULN_{02}/BVULN_{79–88}$ (%)	131	152	153	182	131	152	154	184	128	149	151	183
$BVULN_{07}/BVULN_{02}$ (%)	67	101	105	157	64	98	103	158	73	102	108	161
$BVULN_{07}/BVULN_{79–88}$ (%)	94	156	162	250	91	152	160	250	103	156	163	249

A sensitivity trial that was evaluated using the MCMC procedure involved changing the assumption that male spring-summer vulnerability is 1 and that the other sex/season vulnerabilities are less than or equal to this value. In this sensitivity trial, the assumption was changed to make the autumn-winter vulnerability for males highest and with the other vulnerabilities relatively less. These results are similar to the base case results (Table 23Table). The exploitation rates estimated in this sensitivity trial are very similar to the exploitation rates estimated by the base case.

Stock assessment results: *Jasus edwardsii*, CRA 2

The base case assessment for CRA 2 was obtained by first making the standard deviations of standardised residuals from all data sets close to 1 by adjusting the relative weights for each data set. However, it was necessary to further increase the weight on CPUE data until a satisfactory fit to all data sets was achieved. As in the CRA 3 assessment last year the model appears to have trouble fitting the steep decline in CPUE after 1998: it expects more large lobsters to remain in the population and consequently expects CPUE to remain higher than was observed.

Base case results suggested that biomass decreased to a low point in 1977, increased to 1980, declined slowly through 1988, increased strongly to a peak in 1998 and then declined again (Figure 12). Seasonal exploitation rate peaked in the mid-1980s near 50% for the spring-summer fishery, and is currently in the 20–25% range.

A series of sensitivity trials suggested that the results were generally robust to these trials (based on MPD estimates). A set of retrospective analyses on the MPD fits showed a strong effect to removing data from 1999, the year when CPUE began to decrease strongly. Fits to the spring-summer CPUE did not change much, indicating the problem is probably caused by the 1999 autumn-winter CPUE data point. This retrospective model estimates a much higher *M* and higher biomass than in the base case and suggests that the model has difficulty in predicting the extent of the decline between 1999 and 2001 based solely on the data available up to 1999.

The assessment results (Table 24) are based on the posterior distributions of indicators. These were obtained from MCMC simulations – for CRA 2, five chains of 600 000 simulations each were started from the likelihood profile on Ln(*R0*). Diagnostics were acceptable, and the results are based on 4950 samples remaining after the first 10 samples were discarded from each chain. Results suggest that vulnerable biomass is currently about 50% higher (0.05 and 0.95 quantiles were 30% to 70%) than in the reference period. At the current levels of catch and using recruitments sampled from 1989–98, the median expectation is that biomass will remain at current levels over five years, but with considerable uncertainty (0.05 and 0.95 quantiles were 35% to 170% of current biomass).

Table 24: Summary statistics for performance indicators from posterior distributions from CRA 2. Biomass indicators are shown in t.

	Basecase				Estimate male SS vulnerability				Alternative recreational catch trajectory			
Indicator	0.05	median	mean	0.95	0.05	median	mean	0.95	0.05	median	mean	0.95
$BALL_{79–88}$	1 592	1 656	1 657	1 723	1 443	1 499	1 499	1 561	1 625	1 699	1 699	1 773
$BRECT_{79–88}$	525	555	556	589	479	504	505	532	565	603	603	640
$BVULN_{79–88}$	391	412	413	435	362	380	381	400	414	440	440	465
$BALL_{02}$	1 807	2 170	2 176	2 571	1 578	1 997	1 997	2 428	1 886	2 292	2 296	2 723
$BRECT_{02}$	1 025	1 150	1 150	1 275	889	1 027	1 028	1 169	1 064	1 198	1 197	1 330
$BVULN_{02}$	527	619	621	716	485	588	589	696	547	647	648	750
$BALL_{07}$	1 284	2 122	2 135	3 037	1 144	2 004	2 017	2 911	1 264	2 190	2 202	3 191
$BRECT_{07}$	372	1 033	1 047	1 757	291	1 001	1 006	1 733	264	1 028	1 040	1 822
$BVULN_{07}$	199	614	631	1 117	173	612	621	1 101	153	604	621	1 142
$UNSL_{02}$ (%)	3.7	4.2	4.2	4.9	3.7	4.4	4.5	5.3	3.5	4.0	4.0	4.7
USL_{02} (%)	21.6	25.0	25.1	29.2	22.2	26.2	26.5	31.8	21.4	24.9	25.0	29.3
$UNSL_{06}$ (%)	2.8	4.4	4.8	8.4	2.8	4.4	5.1	9.9	2.7	4.3	4.9	9.3
USL_{06} (%)	15.2	25.7	30.0	59.3	15.4	26.2	31.8	73.1	15.2	26.2	31.8	72.1
$BVULN_{02}/BVULN_{79–88}$ (%)	130	150	150	171	129	154	155	181	127	146	147	169
$BVULN_{07}/BVULN_{02}$ (%)	34	99	101	170	33	104	104	176	26	93	94	167
$BVULN_{07}/BVULN_{79–88}$ (%)	48	149	153	271	46	161	163	290	35	137	141	258

A sensitivity trial that was evaluated using the MCMC procedure involved changing the assumption that male spring-summer vulnerability is 1 and that the other sex/season vulnerabilities are less than or equal to this value. In this sensitivity trial, the assumption was changed to make the autumn-winter vulnerability for males highest and with the other vulnerabilities relatively less. These results are similar to the base case results (Table 24), but the indicators are slightly more optimistic. The exploitation rates estimated in this sensitivity trial are very similar to the exploitation rates estimated by the base case.

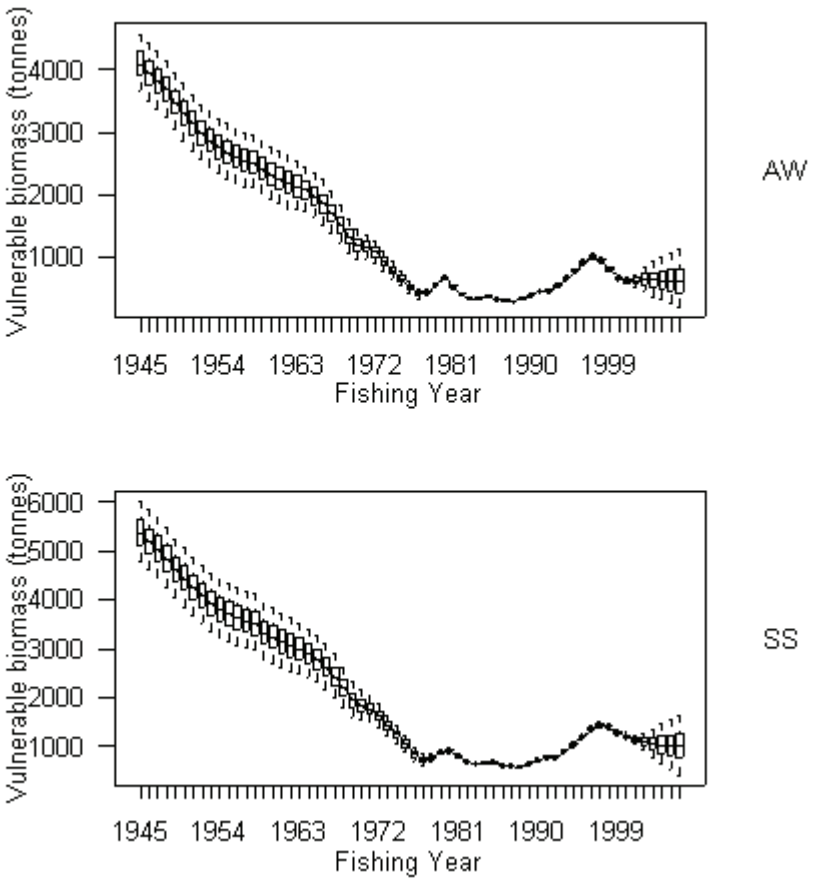


Figure 12: CRA 2: posterior trajectories of vulnerable biomass, for the AW (top) and SS (bottom) seasons, from the CRA 2 base case MCMC simulations. For each year the horizontal line represents the median, the box spans the 25th and 75th percentiles and the dashed whiskers span the 5th and 95th percentiles.

6.2 CRA 3

This section reports assessments for *J. edwardsii* for CRA 3 from the NSC substock taken from the 2008 Mid-year Plenary report (Ministry of Fisheries 2008).

This assessment used a single-stock version of the multi-stock length-based model (MSLM) (Haist et al. 2009). In a simple preliminary trial, the new model was able to reasonably match the MPD results from the 2004 CRA 3 assessment when fitted to the same data.

Catch histories for CRA 3 were agreed by the RLFAWG. Other input data to the model included:

- tag-recapture data from 1975–1981 and from 1995–2006,
- standardised CPUE from 1979–2007,
- historical catch rate data from 1963–1973; and
- length frequency data from commercial catches (log book and catch sampling data) from 1989 to 2007.

Because the predicted growth rates were different for the 1975–1981 and 1995–2006 datasets, the RLFAWG agreed that it would inappropriate to fit the model to the combined tag-recapture dataset (as had been done in the 2004 CRA 3 assessment). Two approaches were used instead. First, the model was altered to permit of fitting to the two tag-recapture datasets separately. This alteration was not a formal generalised change to MSLM, but rather was a one-off change to produce a specialised CRA 3 assessment model. In this version, the growth transition matrix for years up to and including 1981 was based on the 1975–1981 tagging dataset (plus whatever contribution was made by other data sets). The growth transition matrix for years from 1995 onwards was based on the 1995–2006 tagging dataset (plus whatever contribution was made by other datasets). The growth transition matrix

for the intervening years, 1982–1994, was based on an interpolation of the growth transition matrices estimated for the earlier and later periods. The sensitivity of the model predictions to the specified transition years was also examined.

In this version of the model, the size classes represented by the model were specified differently to deal with a technical problem introduced by the new growth rate handling. The midpoint of the first size bin in the model was increased from 31 mm to 45 mm, and the recruiting cohort mean size was increased to midpoint 47 mm from 33 mm. This was done to avoid growth model misspecification in the small size classes for which there are no observations.

In the second approach, the model was fitted to data from 1983 onwards, using only the 1995–2006 tag-recapture data. This approach was rejected by the RLFAWG, based on the diagnostics of the model and the value of some of the parameters in the results, and will not be described further.

The start date for the accepted model was 1945, with an annual time step through 1973 and then switching to a seasonal time step from 1974 onward: autumn/winter (AW), extending from April to September, and spring/summer (SS), extending from October to March. The last fishing year in the minimisations was 2007, and projections were made through 2012 (five years). Two selectivity epochs were modelled, with the change made in 1993 to capture regulation shifts for the pot escape gaps. Recruitment deviations were estimated from 1945 through 2004. Maximum vulnerability was assumed to be for males in the SS season. A marine reserve was modelled, beginning in 1999 and alienating 10% of the habitat. The model was fit to CPUE, the historical catch rate series, length frequency (LF) data and the two tag-recapture datasets. No pre-recruit index was fit, and the puerulus settlement index was fit in a separate randomisation trial.

A log-normal prior was specified for M, with mean 0.12 and c.v. of 0.4. A normal prior was specified for the recruitment deviations in log space, with mean 0 and standard deviation 0.4. Priors for all other parameters were specified as uniform distributions with wide bounds.

Other model options used in the reference case were:

- the dynamics option was set to instantaneous;
- selectivity was set to the double normal form used in previous assessments;
- movements were turned off;
- the relation between CPUE and biomass was fixed to linear;
- maturity parameters were fixed at values estimated outside the model;
- the growth c.v. was fixed to 0.5 to stabilise the analysis;
- the right-hand limb of the selectivity curve was fixed to 200 as in previous assessments;
- dataset weights were adjusted to attempt to obtain standard deviations of normalised residuals of 1.0 or medians of absolute residuals of 0.67.

The RLFAWG considered results from the mode of the joint posterior distribution (MPD) results and the results of 13 sets of MPD sensitivity trials:

- altering the specification of the growth transition period,
- varying the transition period between tag data sets,
- using finite dynamics instead of instantaneous,
- varying start year and initial exploitation rate,
- estimating the relation between CPUE and biomass,
- estimating the CV of predicted growth increments,
- estimating maturity parameters,
- fixing the size at maximum selectivity for females to 60,
- fixing M to 0.12 (the mean of the prior),
- removing data sets one at a time
- estimating the right-hand limb of selectivity for both sexes and epochs,
- ignoring the marine reserve,
- fitting to puerulus settlement data and
- adding uncertainty to NSL catches as requested by the WG

Most base case results showed limited sensitivity to these trials, with some notable exceptions being the removal of CPUE data or, to a lesser extent, removal of tag-recapture data. The indicator ratios were reasonably stable, but some sensitivity was observed to model starts after 1945 with different assumed values for initial exploitation rate. Overall, it was not possible to draw strong conclusions from the sensitivity trials, given that the median and mean of the assessment posterior distributions moved a considerable distance from the MPD estimates.

The assessment was based on Markov chain – Monte Carlo (McMC) simulation results. We started the simulation at the base case MPD, and made a chain of three million, with samples saved every 1000 samples, for a sample size of 3000. From the joint posterior distribution of parameter estimates, forward projections were made through 2012. In these projections, catches were assumed to remain constant at their 2007 values, except that the TACC of 190 t was used for commercial catch (which is about 20 t greater than the 2007 commercial catch). The 2007 commercial catch seasonal split was used. Recruitment was re-sampled from 1995-2004, and the estimates for 2005–2007 were overwritten. These projections are sensitive to the period chosen from which to re-sample recruitment, because recruitment trends are different over different periods. The most recent ten years' estimates are considered the best information about likely future recruitments in the short term.

The RLFAWG agreed on a set of indicators. Some of these were based on beginning of season AW vulnerable biomass: the biomass legally and functionally available to the fishery, taking MLS, female maturity, selectivity-at-size and seasonal vulnerability into account. The limit indicator *Bmin* was defined as the nadir of the vulnerable biomass trajectory (using current MLS), 1945-2007. Current biomass, *B2008*, was taken as vulnerable biomass in AW 2008, and projected biomass, *B2012*, was taken from AW 2012.

A biomass indicator associated with *MSY* or maximum yield, *Bmsy*, was calculated by doing deterministic forward projections for 50 years, using the mean of estimated recruitments from 1979-2004. This period was chosen to represent the recruitments that were estimated from adequate data, and represents the best available information about likely long-term average recruitment. These *MSY* and *Bmsy* calculations are sensitive to the period chosen to represent the mean recruitment, which varies substantially over the range of the period available, causing variation in estimated *Bmsy*. It was agreed to hold the non size-limited (NSL) catches (customary and illegal) constant at their assumed 2007 values, to vary the SL fishery mortality rate *F* to maximise the annual size-limited (SL) catch, and to record the associated AW biomass.

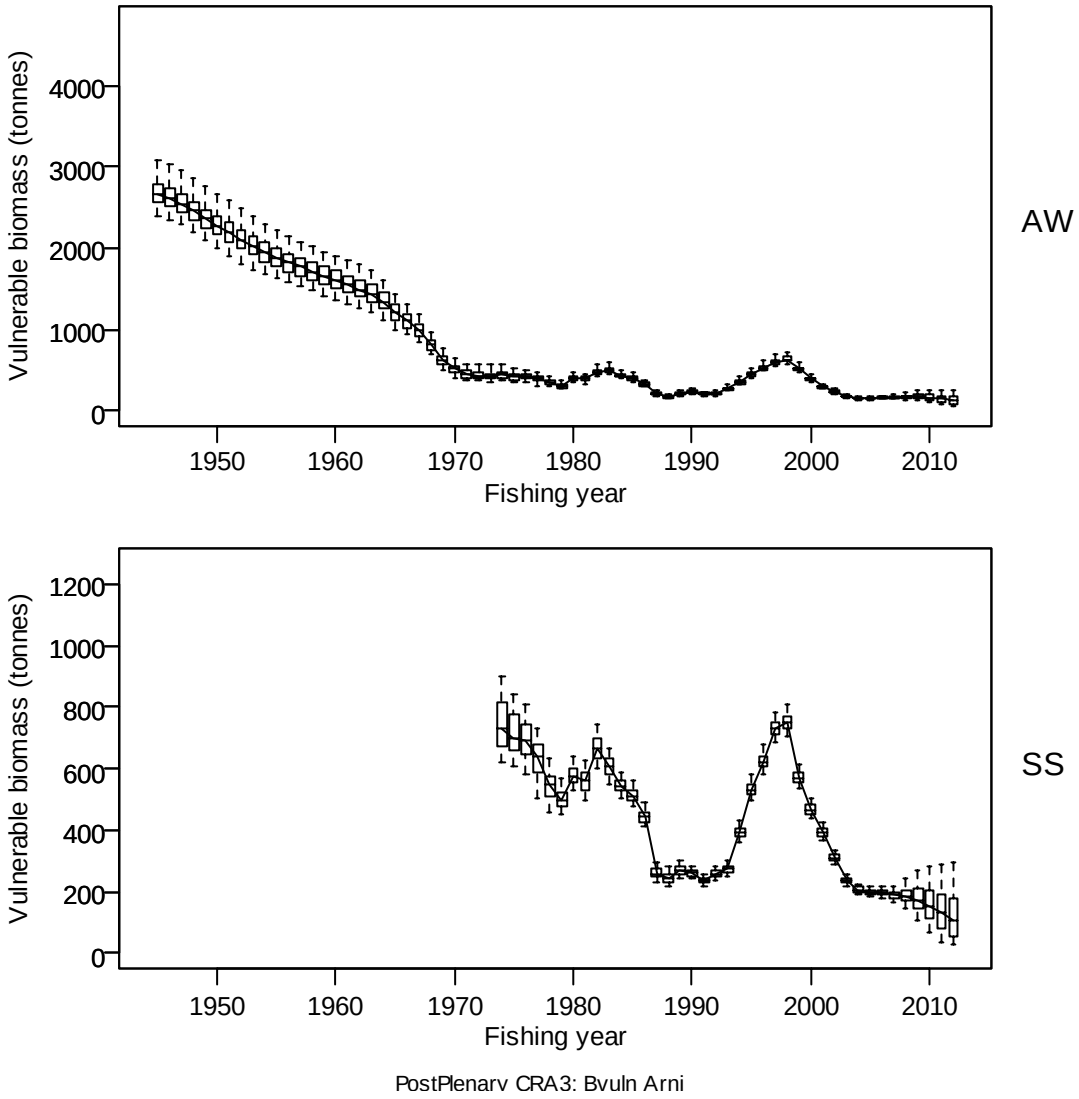


Figure 13: The posterior trajectory of vulnerable biomass, by season, from the CRA 3 base case McMC simulations, including the projections from 2008-12. For each year the horizontal line represents the median, the box spans the 25th and 75th percentiles and the dashed whiskers span the 5th and 95th percentiles. Values in the AW panel before 1974 reference a complete year rather than the AW season.

MSY was the maximum yield (the sum of AW and SS "size-limited" [SL] catches) found by searching across a range of multipliers (from 0.1 to 2.5) on the AW and SS *F* values that were estimated for 2007 for the SL catch for each of the 3000 samples from the joint posterior distribution. The model used a Newton-Raphson algorithm to find the NSL fishery mortality rates. The AW vulnerable biomass associated with the *MSY* was taken to be *Bmsy*. If the *MSY* were still increasing with the highest *F* multiplier, the *MSY* and *Bmsy* obtained with that multiplier were used. The multiplier, *Fmult*, was also reported as an indicator. The *MSY* and *Bmsy* calculations were based on the growth parameters estimated from the second (1996–2006) tag dataset.

We also used as indicators the exploitation rate associated with the SL catch from 2007 and 2012: *USL2007* and *USL2012* respectively. At the request of the National Rock Lobster Management Group we also compared projected CPUE with an arbitrary target of 0.75 kg/potlift.

The assessment was based on the medians of posterior distributions of these indicators, the posterior distributions of ratios of these indicators, and probabilities that various propositions were true in the posterior distributions.

The primary diagnostics used to evaluate the convergence of the McMC were the appearance of the traces, running quantiles and moving means. The trace for *M* was not as well mixed as one could hope to see and showed some drift throughout the run, with higher values towards the end. The running quantile plots for many estimated parameters also showed a drift through the run, suggesting poor convergence, and a trend to move well away from the MPD estimate. Diagnostic plots of the indicators, however, tended to be more acceptable than those of the parameters.

The posterior trajectory of vulnerable biomass by season from 1976 (Figure 13) shows a nadir near 1989, a strong increase in the 1990s followed by a sharp decrease, and variable projections with an decreasing median. The trajectory of biomass from 1945 to 1960 is difficult to explain as there were only low catches throughout this period; the model output shows low recruitments estimated for these years.

The assessment results are summarised in Table 25. *Bmsy* and *MSY* from the base case were calculated with growth estimates based on the later and slower growth dataset. Current biomass (2008) was above *Bmin* in 83% of runs, and the median result was 11% above *Bmin*. Current biomass was above *Bmsy* in less than 1% of runs, and the median result was half *Bmsy*. Current exploitation rate was about 55%.

Table 25: Quantities of interest to the assessment from the model base case McMCs. USL is the exploitation rate that produces the size-limited catch. All biomass values are in tonnes and represent the beginning of season AW vulnerable biomass.

Type	Indicator	Statistic	Value	5%	95%
biomass	*Bmin*	median	149.1	134.4	172.2
	B2008	median	167.1	135.1	218.7
	B2012	median	123.7	64.9	255.6
	Bmsy	median	330.4	301.2	378.1
CPUE	*CPUEcurr*	median	0.662	0.547	0.835
	CPUE2012	median	0.492	0.260	0.989
	CPUEmsy	median	1.314	1.178	1.476
yield	*MSY*	median	300.4	291.2	310.2
biomass ratios	*B2008/Bmin*	median	1.114	0.936	1.400
	B2008/Bmsy	median	0.505	0.406	0.643
	B2012/B2008	median	0.746	0.424	1.347
	B2012/Bmin	median	0.831	0.445	1.662
	B2012/Bmsy	median	0.372	0.195	0.759
fishing mortality	*USL2007*	median	0.550	0.461	0.621
	USL2012	median	0.811	0.392	1.546
	USL2012/USL2007	median	1.478	0.733	2.761
	Fmult	mean	0.727		
probabilities	P(*2008>Bmin*)	mean	82.5%		
	P*(B2008>Bmsy*)	mean	0.0%		
	P*(B2012>B2008*)	mean	24.5%		
	P(*B2012>Bmin*)	mean	36.5%		
	P(*B2012>Bmsy*)	mean	0.5%		
	P(*CPUE2012*>0.75)	mean	19.0%		
	P(*USL2012>USL2007*)	mean	78.9%		

Biomass increased in only 25% of projections, and the median decrease was 25%. Projected biomass had a median of 124 t, but uncertainty around this was high, with a 5% to 95% range of 65 to 256 t. *B2012* was above *Bmin* in 36% of runs, and the median result was 83% of *Bmin*. *B2012* was greater than *Bmsy* in less than 1% of runs, and the median was 37% of *Bmsy*.

Projected CPUE had a median of 0.5 kg/potlift, and only 20% of runs exceeded 0.75 kg/potlift. The mean *F* multiplier associated with *MSY* was about 75% of current *F*.

These results suggest a stock that is near *Bmin* and well below *Bmsy*. Under current catches and recent recruitments the model predicted a 75% probability of biomass decrease over four years.

Projections were made with alternative levels of SL catch (commercial plus recreational) with the NSL catch (illegal and customary) held constant (Table 26). These were 5-year projections made in the same way as the base case projections described above, and were made at the request of the Plenary for the guidance of the NRLMG, stakeholders and MFish.

Table 26: Results of 5-year projections with alternative SL catch levels.

	SL Projection Catch (t)							
Indicator	206.0	185.4	164.8	144.2	123.6	82.4	41.2	0.01
% of current catch	100%	90%	80%	70%	60%	40%	20%	0%
B2012	123.7	160.9	195.3	229.0	262.0	328.6	396.6	463.6
B2012/Bmin	0.831	1.073	1.307	1.532	1.754	2.199	2.645	3.090
B2012/B2008	0.746	0.948	1.151	1.346	1.548	1.942	2.340	2.740
B2012/Bmsy	0.372	0.481	0.586	0.688	0.788	0.989	1.191	1.394
CPUE2012	0.492	0.639	0.775	0.910	1.041	1.303	1.566	1.832
P(*B2012>Bmin*)	36.5%	57.0%	77.4%	92.4%	98.2%	100.0%	100.0%	100.0%
P(*B2012>B2008*)	24.5%	44.4%	67.6%	88.7%	97.7%	100.0%	100.0%	100.0%
P(*B2012>Bmsy*)	0.5%	1.4%	4.0%	9.0%	18.5%	47.8%	83.6%	98.3%
P(*CPUE2012>0.75*)	19.0%	34.6%	53.7%	73.5%	89.1%	99.1%	100.0%	100.0%

6.3 CRA 4

This section reports an assessment for *J. edwardsii* for CRA 4 from the NSC substock taken from the 2005 Mid-year Plenary report (Sullivan et al. 2005).

The CRA 4 fishery extends from the Wairoa River on the east coast, southwards along the Hawke Bay, Wairarapa and Wellington coasts, through Cook Strait and north to the Manawatu River.

A CRA 4 TAC was first set in April 1999 and remains at 771 tonnes. In that decision, the TACC was increased from 495.7 tonnes to 577 tonnes, based on a stock assessment made in 1998. Before 1999, the TACC had remained unchanged since April 1993. Within the TAC, allowances were made of 85 t for amateur and 35 t for customary catches, and an implicit allowance of 74 t for illegal catch. A stock assessment was made for CRA 4 in 2003 which did not result in any adjustment to the TAC or TACC.

The TACC of 577 t is distributed amongst 89 quota share owners. The fleet comprised an estimated 64 vessels (Starr 2009) in the 2003–04 commercial season, most operating from coastal bases in isolated rural areas. The CRA 4 commercial catch has a landed value of more than $18 million, based on the average landed value, and supports several processing and export operations in Napier and Wellington, Auckland and Canterbury.

The recreational catch history is unknown but was assumed as described in section 1 above, based on the 1994 and 1996 recreational surveys. Most recreational catch is taken in summer by potting and diving.

A comprehensive stock monitoring programme has been established in the CRA 4 fishery. There is a long time series of intensive catch sampling data from Napier, Castlepoint, Cape Palliser, and the Wellington south coast. This series was extended in 2004-05 with 35 samples (days), and 45 samples are planned for 2005-06. Tag recapture data are being routinely reported by commercial fishermen, and 4000 lobsters will be tagged in CRA 4 in 2005-06.

The seasonal CPUE for the 2005 autumn-winter period was estimated using a projection regression model fitted to partial season data (Rock Lobster Working Group document 2005/02). This projection model predicts the seasonal CPUE index using the pattern of historical CPUE indices compared to accumulated partial season data. This model was accepted by the Working Group because it showed good historical prediction performance. The autumn-winter and spring-summer catches for 2005 were also estimated from partial reported data, including allowing an expected overall shortfall of about 35 t from the TACC. Some length frequency data were also available for the 2005 autumn-winter season. The use of these partial year data allowed the extension of the assessment model to the end of 2005 and moved the start of the projection period to the autumn-winter of 2006.

Model structure

The length-based model, used in 2002 (Starr et al. 2003), 2003 (Kim et al. 2004) and 2004 (Haist et al. 2005), was used without major revision for the 2005 assessment. The model was fitted to two series of catch rate indices from different periods, and to size frequency and tag-recapture data. The

model has three sex categories: male, immature female and mature female, and estimates a maturation schedule for females.

In the model, a year is divided into two seasons: autumn-winter (AW): April through September, and spring-summer (SS): October through March. This captures several biological processes: season- and sex-specific moult patterns, differential seasonal vulnerability between sexes, and a reduction in vulnerability of mature females greater than the MLS in the AW season because of their egg-bearing status. Seasonal structure is important to incorporate because, in the mid 1990s, several fisheries changed from predominantly SS fisheries to AW fisheries that caught mostly male lobsters (this trend has been partially reversed in some areas, including CRA 4).

Significant catches occurred in CRA 4 during the early part of the time series. Different MLS regulations existed in the past and escapement regulations have changed. We therefore incorporate historical information for CRA 4: time series of historical catches, sex-specific MLS regulations and catch per day estimates for the 1960s and early 1970s. Data and their sources are listed in Table 23.

The initial population in 1945 is assumed to be in equilibrium with base recruitment and with no fishing mortality. Each season the number of male, immature female and mature female lobsters within each size class is updated as a result of:

a) **Recruitment**. Each year, new recruits are added equally for each sex and both seasons, into the smallest size classes, beginning with the AW season. The proportion of individuals recruiting to each size class is modelled as a normal distribution with a mean of 32 mm and a standard deviation of 2 mm. This distribution is truncated at the smallest size class in the model (30 mm). Recruitment in a specific year is the product of the base recruitment parameter and an annual deviation parameter. The vector of recruitment deviations is assumed to be normally distributed with assumed standard deviation 0.4. The years for which recruitment deviations were estimated were 1945 to 2003, with the last deviation also applied to 2004 and 2005 in minimisations.

b) **Mortality**. Natural, fishing and handling mortalities are applied to numbers in every sex/size class. Estimated natural mortality is assumed to be independent of sex, year and length. Fishing mortality is determined from observed catch and model biomass, modified by legal sizes, sex-specific seasonal vulnerabilities and size-specific selectivity curves.

   Fisheries that respect size limits (SL fisheries – legal commercial and recreational) are differentiated from those which do not (NSL fisheries – most of the illegal fishery plus the Mäori customary fishery). It is assumed that size limits and the prohibition of taking berried females apply only to the SL fisheries. Otherwise, selectivity and seasonal vulnerability functions are the same for the SL and NSL fisheries. Relative vulnerability is calculated by assuming that a specified sex in a specified season has the highest vulnerability and estimating the relative vulnerability for other sex/season combinations. Mature females have no legal vulnerability in the autumn-winter, when all are assumed to be ovigerous. The annual rate of SL fishing mortality is calculated as the ratio of catch to the SL biomass, where catch includes both the legal catch and the portion of NSL catch taken from the SL biomass. SL biomass is defined as the weight of males and females in the size classes above the MLS limits, adjusted for their relative vulnerability as defined above. Handling mortality rate is assumed to be proportional to legal fishing mortality at 10% of all lobsters that are released.

c) **Fishery selectivity curves:** A three-parameter fishery selectivity function is assumed, with parameters describing increasing vulnerability from the initial size class to a maximum, followed by decreasing vulnerability. The three parameters describe the shapes of the ascending and descending limbs and the size at which vulnerability is maximum. Changes in regulations over time (for instance, changes in escape gap regulations) are modelled by estimating separate selectivity parameters appropriate to each period of the fishery. For the CRA 4 assessment, the shape of the right-hand part of the curve was assumed to be flat.

d) **Growth and maturity**. For each sex in each season, a growth transition matrix specifies the probability of an individual remaining in the same size class or growing into a different size class. Maturity for females is estimated as a two-parameter logistic curve from the maturity-at-size information in the size frequency data, but for the CRA 4 assessment there were few immature females in the data, reflecting a small size at maturity, and one maturity parameter was assumed.

Model fitting

A total negative log likelihood function was minimised using AD Model Builder™. The model was fitted to standardised CPUE indices estimated by season from 1979–80 through to the autumn-winter of 2005–06 fishing years. The index for the most recent period (AW 2005) was estimated using a regression method which predicts the seasonal CPUE based on partial in-season data (up to July 2005) (working group paper RLWG2005/02). The model was also fitted to an additional seasonal catch rate index based on daily catch and effort data for the period 1963 to 1973 (Annala & King 1983). A lognormal error structure was assumed for abundance indices and a normal error structure for tag-recapture data and proportions-at-length.

The model was fitted to size data (proportions-at-length) taken from commercial pots, data obtained from research sampling conducted on commercial vessels. Voluntary logbooks were maintained by only one rock lobster fisherman in CRA 4 and were not considered sufficiently representative of the whole fishery to be included as input to the assessment. Estimates of the seasonal size frequency were summarised by area/month strata and weighted by the commercial catch taken in each stratum, the number of lobsters measured and the number of days sampled. A fundamental assumption is that the size frequency data are representative of the commercial lobster catch. Size proportions within each season are normalised to one across all three sex categories, providing the model with seasonal estimates of the relative proportion-at-size by sex.

Tag-recapture data come from all tagging projects conducted. Because the numbers of recoveries of small and large lobsters were limited, the CRA 4 tag data were augmented with an equal number of records from CRA 3 and CRA 5, after first establishing that the growth rates within the sizes of overlap in the data were similar.

A summary of data used, data sources and the applicable years are provided in Table 27. For this assessment it was observed that few tag-recapture data involved larger lobsters.

Table 27: Data types and sources for the 2005 assessment for CRA 4. Year codes apply to the first 9 months of each fishing year, viz. 1998–99 is called 1998. MFish: NZ Ministry of Fisheries; NZ NZRLIC: Rock Lobster Industry Council. –: not applicable.

Data type	Data source	Begin year	End year	Number
Historical catch rate	Annala & King (1983)	1963	1973	21
CPUE	FSU & CELR	1979	2005 (AW)	53
Observer proportions-at-size	MFish and NZ NZRLIC	1986	2003	33
Tag recovery data	NZ NZRLIC & MFish	1998	2004	2146
Historical MLS regulations	Annala (1983), MFish	1945	2004	–
Escape gap regulation changes	Annala (1983), MFish	1945	2004	–

The parameters estimated and the priors used are provided in Table 28. Fixed parameters and their values are given in Table 29.

CPUE, the historical catch rate, the proportions-at-length and tagging data were weighted directly by a relative weighting factor, and the assessment attempted to obtain standard deviations of standardised residuals for each data set that were close to one.

Table 28: Parameters estimated and priors used in basecase assessments for CRA 4. Prior type abbreviations: U– uniform; N – normal; L – lognormal.

	Prior Type	Lower bound	Upper bound	Mean	CV
Log R_0 (ln mean recruitment)	U	1	25	–	–
M (natural mortality)	L	0.01	0.35	0.12	0.4
Recruitment deviations	N [1]	-2.3	2.3	0	0.4
LogqI	U	-25	0	–	–
LogqCR	U	-25	2	–	–
Increment at TW=50 (male & female)	U	1	8	–	–
Difference between increments at TW=80, TW=50	U	0.001	30	–	–
Shape of length-growth increment relation	U	0.1	20	–	–
Relative sex/season vulnerability: [2]	U	0	1	–	–
Shape of ascending limb of vulnerability ogive	U	1	50	–	–

[1] Normal in logspace = lognormal (bounds equivalent to – 10 to 10).
[2] Relative vulnerability of males in autumn-winter was fixed at one.

Table 29: Fixed values used in basecase assessment for CRA 4.

Quantity	CRA 4
Common error component (sigma tilde)	0.1108
(TW at 95% probability female maturity) – (TW at 50% probability female maturity)	20 mm
Shape parameter for biomass-CPUE relation	1
Minimum std dev of growth increment	1 mm
Std dev of observation error of increment	2.68 mm
Growth CV (male and female)	0.5
Shape of descending limb of vulnerability ogive	200
Std dev of historical catch per day	0.30
Maximum exploitation rate per season	90%
Handling mortality	10%
Process error for CPUE	0.25
Process error for historical catch rate	0.3
Year of selectivity change	1993
Current male size limit	54
Current female size limit	60
First year for recruitment deviations	1945
Last year for recruitment deviations	2003
Relative weight for length frequencies	1.25
Relative weight for CPUE	0.317
Relative weight for CR	0.5
Relative weight for tag-recapture data	0.5
Sex-season with maximum vulnerability	male (AW)

Model projections

Bayesian estimation procedures were used to estimate uncertainty in model estimates of current biomass and in future projections. This procedure was conducted in the following steps:

a) Model parameters were estimated by AD Model Builder™ using maximum likelihood and the prior probabilities. These point estimates represent the mode of the joint posterior distributions of the parameters, and are called the MPD estimates;

b) Samples from the joint posterior distribution of parameters were generated using a Markov chain – Monte Carlo procedure (MCMC) and the Hastings-Metropolis algorithm;

c) For each sample of the posterior, 3-year projections (encompassing the 2006–07 to 2009–10 fishing years) were generated by assuming the catches indicated in Table 30. Future annual recruitment was randomly sampled with replacement from the model's estimated recruitments from the period 1994–2003;

d) A marginal posterior distribution was found for each quantity of interest by integrating the product of the likelihood and the priors over all model parameters; the posterior distribution was described by the mean, median, and 5th and 95th percentiles.

At the request of the RLWG, projections were made with both our “best estimate” of future catch - comprising the TACC plus the current estimates of non-commercial catch and with the allowances specified in the TAC (Table 30). For both sets of projections, the current split of AW and SS was used.

Table 30: Catches (t) used in the 3-year projections for CRA 4. Two sets of projected catches were used: one based on the TACC and the current "best" estimates of recreational, customary and illegal catches; the other based on the allowances in the TAC. The "reported illegal" catches are subtracted from the legal commercial catch.

	Size-limited (SL) catch			Not size-limited (NSL) catch			
Catch category	Commercial	Recreational	Total	Reported illegal	Unreported illegal	Customary	Total
"Best" estimate of catch	571	47	618	5	35	20	60
TAC allowances	567	85	652	10	64	35	109

Performance indicators

The assessment used several performance indicators based on biomass and exploitation rate, all using beginning season biomass legally available and vulnerable to the fishery (e.g. above MLS and non-berried females) in the autumn-winter season (vulnerable biomass). The minimum biomass indicator, B_{min}, varies between MCMC draws, so it is not possible to define a single year as the expected minimum biomass. Current biomass, $B_{current}$, is taken from the autumn-winter season of 2006 because the assessment extends to the end of 2005 (see above). Projected biomass, B_{proj}, is taken from the autumn-winter season of 2009. A list of the projection performance indicators is provided in Table 31.

Table 31: Performance indicators for the 2004 CRA 4 stock assessment projections

$\boldsymbol{B}_{ref}$	mean of AW vulnerable biomass from 1979–88
$\boldsymbol{B}_{min}$	nadir of AW vulnerable biomass
$\boldsymbol{B}_{current}$	2006 AW vulnerable biomass
$\boldsymbol{U}_{current}$	AW exploitation rate on the SL biomass in 2005
$\boldsymbol{B}_{proj}$	2009 AW biomass
$\boldsymbol{U}_{proj}$	AW exploitation rate on the SL biomass in 2008
$\boldsymbol{B}_{current} / \boldsymbol{B}_{ref}$	ratio: current biomass to reference biomass
$\boldsymbol{B}_{current} / \boldsymbol{B}_{min}$	ratio: current biomass to minimum biomass
$\boldsymbol{B}_{proj} / \boldsymbol{B}_{ref}$	ratio: projected biomass to reference biomass
$\boldsymbol{B}_{proj} / \boldsymbol{B}_{current}$	ratio: projected biomass to current biomass
$\boldsymbol{B}_{proj} / \boldsymbol{B}_{min}$	ratio: projected biomass to minimum biomass
$\boldsymbol{U}_{proj} / \boldsymbol{U}_{current}$	ratio: projected exploitation rate to current exploitation rate
$\boldsymbol{P}\left(\boldsymbol{B}_{proj} < \boldsymbol{B}_{current}\right)$	probability projected biomass is less than current biomass
$\boldsymbol{P}\left(\boldsymbol{B}_{proj} < \boldsymbol{B}_{ref}\right)$	probability projected biomass is less than reference biomass
$\boldsymbol{P}\left(\boldsymbol{B}_{proj} < \boldsymbol{B}_{min}\right)$	probability projected biomass is less than minimum biomass

Stock assessment results - *Jasus edwardsii*, CRA 4

The base case assessment chosen for CRA 4 (Table 32) resulted from extensive exploration of about 200 alternative runs. Initially, the various datasets were given natural weightings by trying to obtain standard deviations of normalised residuals (sdnr) from all data sets that were close to 1. However, in most cases this resulted in poor fits to the CPUE data; also some key parameters were estimated at their bounds and the maximum exploitation bound was reached. By upweighting the CPUE data, better fits to the recent CPUE were obtained. However, these model runs were not robust to small changes in model structure assumptions and both the length frequency data and the tag data showed a greater than expected number of very large residuals. Satisfactory runs were found by downweighting the length frequency and tag data and fixing the common error component (instead of fitting this value) so that the model was able to fit the data more freely. The chosen basecase gave a value of approximately 1 for the sdnr for CPUE, decreased the number of large residuals in the length frequency and tag data and the maximum exploitation rate stayed below 0.9. The WG noted that there was more uncertainty with this assessment than indicated by the basecase outputs because of the sensitivity shown to the data weighting.

Base case results suggested that the index biomass decreased to stable but low levels throughout the 1980s and early 1990s (Figure 14). This period coincided with the largest catches from the QMA in

the mid-1980s. However, catches and apparent productivity had declined by the early 1990s. The biomass then increased strongly to a peak in 1998 and has since declined. Exploitation rate peaked in the 1990 spring-summer season, but the base case and most of the sensitivity runs did not reach the assumed maximum exploitation rate (Table 29). Recent exploitation rates appear to be around 20-30% of the vulnerable biomass (Table 32).

Three MCMC sensitivity trials were made, including a) a "domed" trial where the right-hand limb of the selectivity function was estimated, allowing it to descend to obtain a better fit to the data; b) a trial where a non-linear fit was allowed to the CPUE data; and c) a trial where the non-commercial catches were arbitrarily doubled. Three retrospective MCMC sensitivity trials were also done, stepping backward one year at a time from 2004 to 2002 and refitting the model to the remaining data. These sensitivities investigated the major uncertainties in the basecase assessment.

Table 32: Summary statistics for performance indicators from posterior distributions from the CRA 4 basecase assessment. Biomass indicators are shown in tonnes.

Indicator	5%	Median	95%
B_{ref}	393	478	580
B_{min}	278	360	455
$B_{current}$	677	855	1068
$U_{current}$	21%	25%	30%
B_{proj}	426	808	1331
U_{proj}	18%	27%	45%
$B_{current}/B_{ref}$	1.50	1.78	2.12
$B_{current}/B_{min}$	1.94	2.37	2.95
B_{proj}/B_{ref}	0.92	1.68	2.73
$B_{proj}/B_{current}$	0.57	0.94	1.39
B_{proj}/B_{min}	1.23	2.24	3.67
$U_{proj}/U_{current}$	0.76	1.11	1.67
$P(B_{proj} < B_{current})$	60%		
$P(B_{proj} < B_{ref})$	7%		
$P(B_{proj} < B_{min})$	2%		

None of the three sensitivity trials resulted in any major differences in stock status, with the non-linear CPUE trial being the most similar to the basecase. The "domed" sensitivity was slightly more optimistic and the "double non-commercial catch" trials was slightly more pessimistic than the basecase, but neither trial provided results which were qualitatively different from those shown in Table 32. The retrospective sensitivities were robust to the removal of the data, with little change in the results over the period investigated.

The assessment results (Table 32) are based on the posterior distributions of indicators. These were obtained from the MCMC simulations – a single chain of 4 million was made and 2000 samples were taken. They suggest that the current vulnerable biomass is currently two to three times B_{min} (0.05 and 0.95 quantiles were 94% to 195% greater than B_{min}) and 78% greater than B_{ref} (50% to 112% greater). Using the "best" estimate of current catches and using historical recruitments sampled from 1994–2003, the median expectation is that biomass will decrease by 6% over three years, but with wide bounds (-43% to +39% of current biomass). The probability of a decrease was 60%, however, the probability of going below the reference biomass is low (7%) as is the probability of going below the minimum biomass (2%).

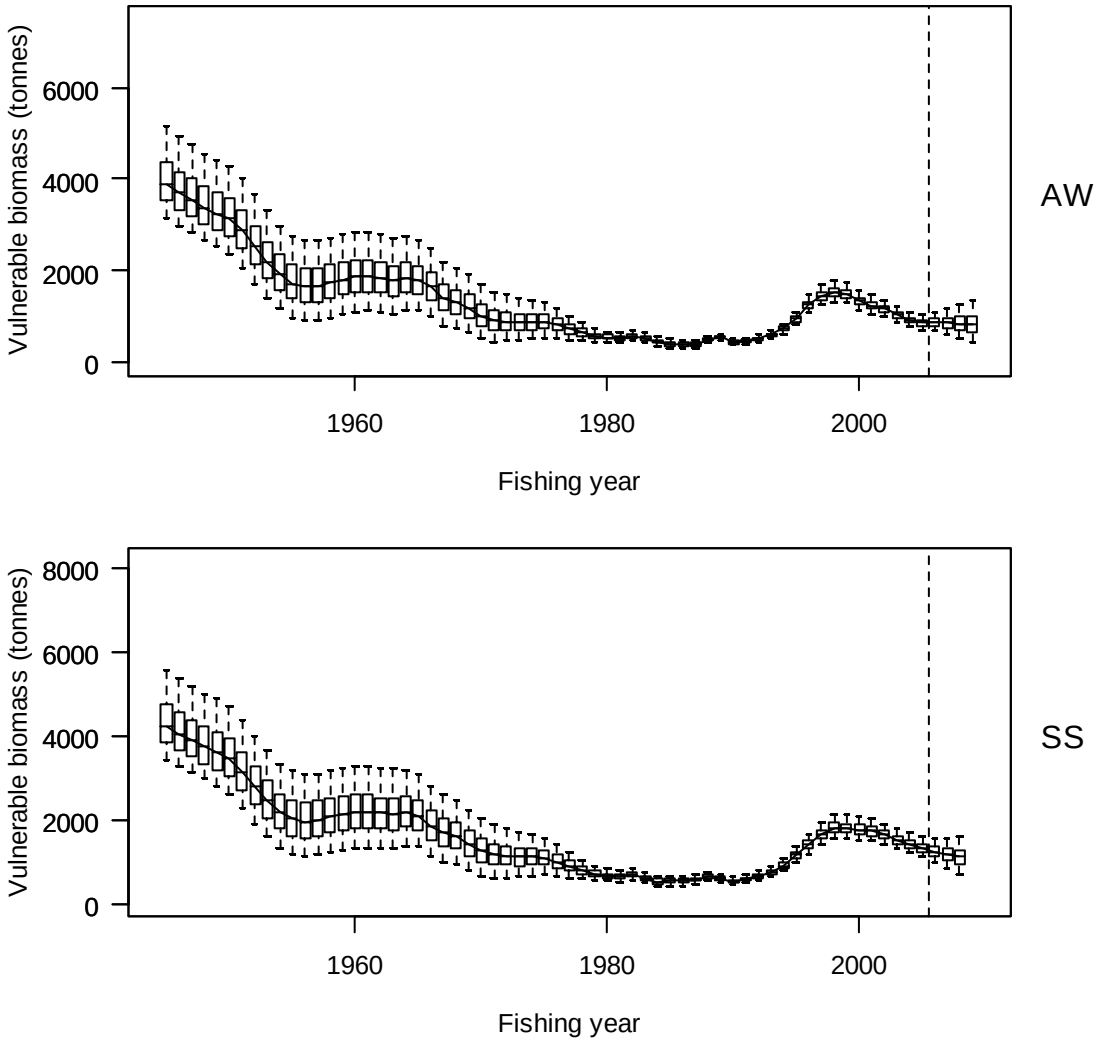


Figure 14: Posterior trajectories of vulnerable biomass, for the AW (top) and SS (bottom) seasons, from the CRA 4 base case MCMC simulations. For each year the horizontal line represents the median, the box spans the 25th and 75th percentiles and the dashed whiskers span the 5th and 95th percentiles. The vertical dashed line shows the beginning of the projection period.

The projections based on the sensitivity trials were also very similar to the basecase, with the "double non-commercial catch" trial giving the same probabilities of decline and exceeding the reference biomass levels as shown in Table 32. The "domed" projections were slightly more optimistic, with only a 50% probability of decline and almost no chance of exceeding the reference biomass levels. The projections rely on an assumption that recruitment would be similar, on average, to that in the 1994–2003 period and with variability as seen in those ten years.

6.4 CRA 5

Model structure

A single-stock version of the multi-stock length-based model (MSLM) (Haist et al. 2009) was fitted to two series of catch rate indices from different periods, and to size frequency, puerulus settlement and tagging data. The model used an annual time step for 1945-78 and then a seasonal time step (autumn-winter (AW): April to September, and spring-summer (SS): October to March).

Significant catches occurred in the early part of the time series for CRA 5. Different MLS regulations existed at this time and pots were not required to have escape gaps. The model incorporated a time series of sex-specific MLS regulations. Data and their sources are listed in Table 33.

The assessment assumed that recreational catch was equal to survey estimates in 1994 and 1996, proportional to area 917 AW CPUE in other years from 1979-2009, and increased linearly from 20% of the 1979 value in 1945 up to the 1979 value.

The initial population in 1945 was assumed to be in equilibrium with average recruitment and with no fishing mortality. Each season the number of male, immature female and mature female lobsters within each size class is updated as a result of:

a) **Recruitment**. Each year, new recruits were added equally for each sex season, as a normal distribution with a mean size (32 mm) and standard deviation (2 mm), truncated at the smallest size class (30 mm). Recruitment in a specific year was determined by the parameter for base recruitment and a parameter for the deviation from base recruitment. The vector of recruitment deviations was assumed to be normally distributed with a mean of zero.

b) **Mortality**. Natural, fishing and handling mortalities were applied to each sex category (male, immature female and mature female) in each size class. Natural mortality was estimated, but was assumed to be constant and independent of sex and length. Fishing mortality was determined from observed catch and model biomass, modified by legal sizes, sex-specific vulnerabilities and selectivity curves.

   Two fisheries were modelled: one fishery that operated only on fish above the size limit (SL fishery – including legal commercial and recreational) and one that did not (NSL fishery - most of the illegal fishery plus the Mäori customary fishery). It was assumed that size limits and the prohibition on berried females applied only to the SL fishery. Otherwise, the selectivity and vulnerability functions were the same for the SL and NSL fisheries. Relative vulnerability was calculated by assuming that the males in the AW had the highest vulnerability and that the vulnerability of all other sex categories by season are equal to or less than the AW males. Instantaneous fishing mortality rates for each fishery were calculated using Newton-Raphson iteration based on catch and model biomass. Handling mortality rate was assumed to be 10% of all lobsters that were released.

c) **Fishery selectivity:** A three-parameter fishery selectivity function was assumed, with parameters describing the shapes of the ascending and descending limbs and the size at which vulnerability is at a maximum. Changes in regulations over time (for instance, changes in escape gap regulations) were modelled by estimating two separate selectivity epoch, pre-1993 and 1993-2009.

d) **Growth and maturity**. For each size class and sex category, a growth transition matrix specified the probability of an individual remaining in the same size class or growing into each of the other size classes. Maturation of females was estimated as a two-parameter logistic curve from the maturity-at-size information in the size frequency data.

Model fitting

A total negative log likelihood function was minimised using AD Model Builder™. The model was fitted to historical catch rate, standardised CPUE (Table 33) and puerulus settlement data using lognormal likelihood. The model was fitted to proportions-at-length with multinomial likelihood and tag-recapture data with robust normal likelihood. For the CPUE and puerulus lognormal likelihoods, CVs for each index value were initially set at the standard error from the GLM analysis. Process error was subsequently added to these CVs so that the overall standard deviation of the standardised (Pearson) residuals was near 1.0. A fixed CV of 0.3 was used for the historical catch rate data. The robust normal likelihood was used for the tagging data so that data outliers (defined as observations with a standardised residual greater than 3.0) would be downweighted. Proportions-at-length, assumed to be representative of the commercial catch, were available from both observer catch sampling and voluntary logbooks; these were fitted separately. Data were summarised by area/month strata and weighted by the commercial catch taken in each stratum, the number of lobsters measured and the number of days sampled. Size data from each source (research sampling or voluntary logbooks) were fitted separately. Seasonal proportions-at-length summed to one across males, immature and mature females. Experiments (randomisation trials) were conducted to establish that puerulus settlement data contained a signal about recruitment.

In the base case, the model's options for fitting a non-linear relation between biomass and CPUE, having density-dependent growth, having a stock-recruit relation and having movements between stocks were all turned off. The base case was obtained by weighting CR, LFs and tags so that standard deviations of normalised residuals were close to 1; CPUE data were intentionally upweighted to force an acceptable fit and puerulus data were also upweighted. It was decided to fix the value of growth c.v. to that estimated in growth-only fits to the tagging data, and to put a prior on the growth shape parameters to avoid unrealistic curves. Recruitment deviations were estimated for the whole time series.

Table 33: Data types and sources for the 2010 assessment for CRA 5. Year codes apply to the first 9 months of each fishing year, viz 1998-99 is called 1998. NA – not applicable or not used; MFish – NZ Ministry of Fisheries; NZRLIC – NZ Rock Lobster Industry Council.

Data type	Data source	Begin year	End year
Historical catch rate CR	Annala & King (1983)	1963	1973
CPUE	FSU & CELR	1979	2009
Observer proportions-at-size	MFish	1986	2009
Logbook proportions-at-size	NZRLIC	1994	2009
Tag recovery data	NZRLIC & MFish	1996	2009
Historical MLS regulations	Annala (1983), MFish	1945	2009
Escape gap regulation changes	Annala (1983), MFish	1945	2009
Puerulus settlement	NIWA	1980	2009

Parameters estimated in each model and their priors are provided in Table 34. Fixed parameters and their values are given in Table 35. CPUE, the historical catch rate, proportions-at-length and tagging data were given relative weights directly by a relative weighting factor. The weights were varied to obtain standard deviations of standardised residuals for each data set that were close to one.

Table 34: Parameters estimated and priors used in basecase assessments for CRA 5. Prior type abbreviations: U – uniform; N – normal; L – lognormal.

	Prior Type	Bounds	Mean	SD	CV
ln(*R0*) (mean recruitment)	U	1–25	–		–
M (natural mortality)	L	0.01–0.35	0.12		0.4
Recruitment deviations	N [1]	-2.3–2.3	0	0.4	
ln(*qCPUE*)	U	-25-0	–		–
ln(*qCR*)	U	-25-2	–		–
ln(*qPuerulus*)	U	-25-0	–		–
Increment at TW=50 (male & female)	U	0.1-20.0	–		–
difference between increment at TW=50 and increment at TW=80 (male & female)	U	0.001-1.000	–		–
shape of growth curve (male & female)	N	0.1-15.0	5.0	0.5	
TW at 50% probability female maturation	U	30–80	–		–
(TW at 95% probability female maturity) – (TW at 50% probability female maturity)	U	5-80	–		–
Relative vulnerability (all sexes and seasons) [2]	U	0-1	–		–
Shape of selectivity left limb (males & females)	U	1–50	–		–
Size at maxim2um selectivity (males & females)	U	30-80	–		–
Size at maximum selectivity females	U	30-80	–		–

[1] Normal in natural log space = lognormal (bounds equivalent to –10 to 10)
[2] Relative vulnerability of males in autumn-winter was fixed at one

Table 35: Fixed values used in base case assessment for CRA 5

	CRA 5
shape parameter for CPUE vs biomass	1
CV of growth increment (male & female)	0.24
minimum std. dev. of growth increment	1.5
Std dev of observation error of increment	1
Std dev of historical catch per day	0.30
Handling mortality	10%
Process error for CPUE	0.25
Year of selectivity change	1993
Current male size limit	54
Current female size limit	60
First year for recruitment deviations	1945
Last year for recruitment deviations	2009
Relative weight for length frequencies	25
Relative weight for CPUE	3
Relative weight for CR	1
Relative weight for puerulus	2
Relative weight for tag-recapture data	0.8

Model projections

Bayesian estimation procedures were used to estimate the uncertainty in model estimates and short-term projections. This procedure was conducted in the following steps:

a) Model parameters were estimated by AD Model Builder™ using maximum likelihood and the prior probabilities. These point estimates are called MPD (mode of the joint posterior) estimates;

b) Samples from the joint posterior distribution of parameters were generated with Markov chain - Monte Carlo (MCMC) simulations using the Hastings-Metropolis algorithm; two million simulations were made, starting from the base case MPD, and 1000 samples were saved. From each sample of the posterior, 5-year projections (2010–2014) were generated with two agreed catch scenarios (Table 36);

c) Future annual recruitment was randomly sampled with replacement from the model's estimated recruitments from 2000–09 (except for the no puerulus sensitivity trial which resampled from 2000–06).

Table 36: Catches (t) used in the five-year projections. Projected catches are based on the current TACC for CRA 5, and the current estimates of recreational, customary and illegal catches.

	Commercial	Recreational	Reported Illegal	Unreported Illegal	Customary
scenario 1	350	156	3	49	10
scenario 2	350	112	3	49	10

Vulnerable biomass in the assessment model was determined by the MLS, selectivity, relative sex and seasonal vulnerability and berried state for mature females. All mature females were assumed to be berried (and not vulnerable to the fishery) in AW and not berried (and vulnerable) in SS.

Base case results suggested that biomass decreased to a low point in 1991, remained low through 1995, then increased (Figure 15). The current vulnerable stock size (AW) is about 3 times the reference biomass and the spawning stock biomass is well above B_{msy} (Table 38). However, projected biomass would decrease at the level of current catches over the next 4 years (Figure 5).

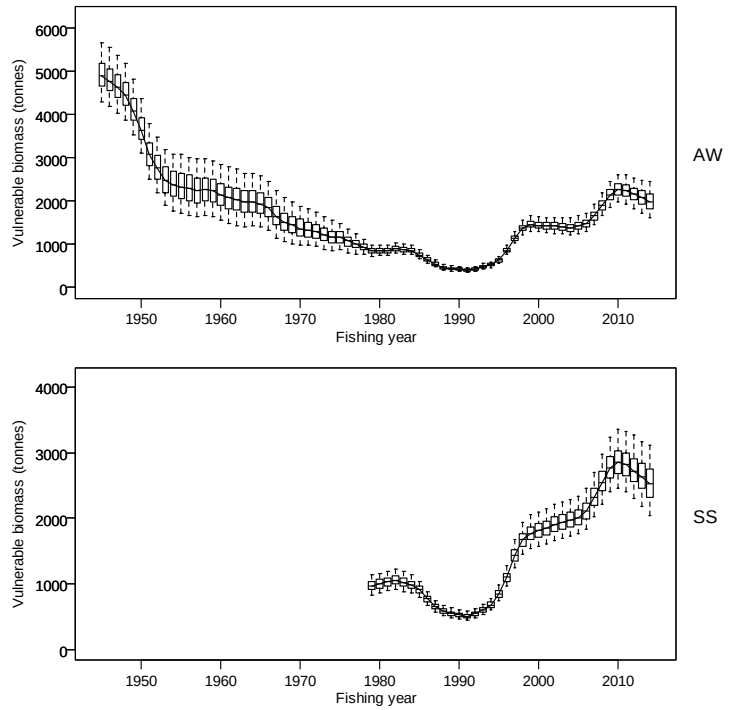


Figure 15: Posterior distributions of the base case McMC biomass vulnerable trajectory. Before 1979 there was a single time step, shown in AW. Projected catches were scenario 1 (Table 36). For each year the horizontal line represents the median, the box spans the 25th and 75th percentiles and the dashed whiskers span the 5th and 95th quantiles.

Table 37. Performance indicators used in the CRA 5 stock assessment

Reference points	
Bmin	The lowest beginning AW vulnerable biomass in the series
Bcurrent	Beginning of season AW vulnerable biomass for the year the stock assessment is performed
Bref	Beginning of AW season mean vulnerable biomass for 1979–88
Bproj	Projected beginning of season AW vulnerable biomass (ie, the year of stock assessment plus 4 years)
Bmsy	Beginning of season AW vulnerable biomass associated with MSY, calculated by doing deterministic forward projections with recruitment *R0* and current fishing patterns
MSY	Maximum sustainable yield (sum of AW and SS SL catches) found by searching a across a range of multipliers on F.
Fmult	The multiplier that produced *MSY*
CPUE indicators	
CPUEcurrent	CPUE at *Bcurrent*
CPUEproj	CPUE at *Bproj*
CPUEmsy	CPUE at *Bmsy*
Performance indicators	
Bcurrent / Bmin	ratio of *Bcurrent* to *Bmin*
Bcurrent / Bref	ratio of *Bcurrent* to *Bref*
Bcurrent / Bmsy	ratio of *Bcurrent* to *Bmsy*
Bproj / Bmin	ratio of *Bproj* to *Bmin*
Bproj / Bcurrent	ratio of *Bproj* to *Bcurrent*
Bproj / Bref	ratio of *Bproj* to *Bref*
Bproj / Bmsy	ratio of *Bproj* to *Bmsy*
USLcurrent	The current exploitation rate for SL catch in AW
USLproj	Projected exploitation rate for SL catch in AW
USLproj/USLcurrent	ratio of SL projected exploitation rate to current SL exploitation rate
Probabilities	
P(Bref> Bmsy)	probability *Bref* > *Bmsy*
P(Bcurrent > Bmin)	probability *Bcurrent* > *Bmin*
P(Bcurrent > Bref)	probability *Bcurrent* > *Bref*
P(Bcurrent > Bmsy)	probability *Bcurrent* > *Bmsy*
P(Bproj > Bmin)	probability *Bproj* > *Bmin*
P(Bproj > Bref)	probability *Bproj* > *Bref*
P(Bproj > Bmsy)	probability *Bproj* > *Bmsy*
P(Bproj > Bcurrent)	probability *Bproj* > *Bcurrent*
P(USLproj > USLcurrent)	probability SL exploitation rate *proj* > SL exploitation rate *current*
P(SSBcurrent < 0.2 SSB0)	soft limit: probability *SSBcurrent* < 20% *SSB0*
P(SSBproj < 0.2 SSB0)	soft limit: probability *SSBproj* < 20% *SSB0*

A series of MCMC sensitivity trials was also made, including exclusion of puerulus data, using a flat recreational catch vector, fixed M, fast growth found in an exploratory trial, density-dependent growth and estimated shape of the CPUE/biomass relation. The assessment results from the base case and sensitivity trials calculated as a series of agreed indicators (Table 37) are shown in Table 38Table for the more aggressive of the two catch scenarios (Scenario 1, Table 36). Indicators from Scenario 2, with lower projected catches, are not reported.

Indicators based on vulnerable biomass (AW) and *Bmsy*

In the base case and for all trials, the median value for *Bref* was larger than the median for *Bmsy* and the probability of *Bref* being greater than *Bmsy* was at least 57%. In the base case and for all trials, current and projected biomass levels were larger than *Bref* and *Bmsy* reference levels by substantial factors for both catch projection scenarios. Projected biomass decreased in most runs but remained well above the reference levels in the base case and for all trials.

Table 38: Assessment results – medians of indicators described in Table 37 from the base case and sensitivity trials under Scenario 1 catches (Table 36); the lower part of the table shows the probabilities that events are true.

	base	no puerulus	flat rec. catch	fixed M	fast growth	d-d growth	non-linear CPUE
Bmin	404	401	462	338	182	263	492
Bcurr	2,266	2,279	2,633	1,943	800	1,503	1,401
Bref	763	754	867	636	345	536	754
Bproj	1,993	2,482	2,397	1,868	650	1,388	1,092
Bmsy	491	492	480	628	316	527	498
CPUEcurrent	1.61	1.63	1.63	1.66	1.39	1.58	1.50
CPUEproj	1.49	1.90	1.57	1.73	1.06	1.55	0.95
CPUEmsy	0.27	0.28	0.19	0.50	0.29	0.48	0.19
MSY	541	535	567	459	537	510	502
Bcurr/Bmin	5.59	5.68	5.72	5.74	4.41	5.67	2.85
Bcurr/Bref	2.96	3.02	3.05	3.05	2.32	2.79	1.86
Bcurr/Bmsy	4.62	4.62	5.54	3.10	2.53	2.88	2.82
Bproj/Bmin	4.91	6.15	5.15	5.51	3.60	5.23	2.23
Bproj/Bcurr	0.88	1.09	0.91	0.95	0.81	0.92	0.78

	base	no puerulus	flat rec. catch	fixed M	fast growth	d-d growth	non-linear CPUE
Bproj/Bref	2.60	3.27	2.75	2.92	1.89	2.57	1.45
Bproj/Bmsy	4.03	5.01	5.03	2.96	2.07	2.66	2.19
USLcurrent	0.122	0.122	0.101	0.145	0.327	0.184	0.187
USLproj	0.131	0.105	0.104	0.139	0.401	0.188	0.239
USLproj/USLcurrent	1.08	0.86	1.03	0.97	1.23	1.03	1.27
Fmult	5.47	5.41	9.51	2.73	4.05	2.97	3.14
P(Bref>Bmsy)	1.000	1.000	1.000	0.568	0.890	0.570	1.000
P(Bcurr>Bmin)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
P(Bcurr>Bref)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
P(Bcurr>Bmsy)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
P(Bproj>Bmin)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
P(Bproj>Bcurr)	0.075	0.787	0.092	0.289	0.162	0.093	0.025
P(Bproj>Bref)	1.000	1.000	1.000	1.000	0.979	1.000	0.991
P(Bproj>Bmsy)	1.000	1.000	1.000	1.000	0.986	1.000	1.000
P(USLproj>USLcurr)	0.804	0.110	0.663	0.360	0.794	0.652	0.960
P(SSBcurr<0.2SSB0)	0	0	0	0	0	0	0
P(SSBproj<0.2SSB0)	0	0	0	0	0	0	0

Indicators based on *SSBmsy*

SSBmsy is biomass of mature females associated with B_{MSY}. The historical track of biomass versus fishing intensity is shown in Figure 16. The phase space in the plot shows biomass on the x-axis and fishing intensity on the y-axis. High biomass/low intensity is in the lower right-hand corner, the location of the stock when fishing first began, and low biomass/high intensity is in the upper left-hand corner, in a period when the fishery was largely uncontrolled. Note that fishing patterns include MLS, selectivity and the seasonal catch split and that *Fmsy* varies in each year because fishing patterns change. The reference *SSBmsy* in Figure 16 has been calculated using the 2009 fishing pattern.

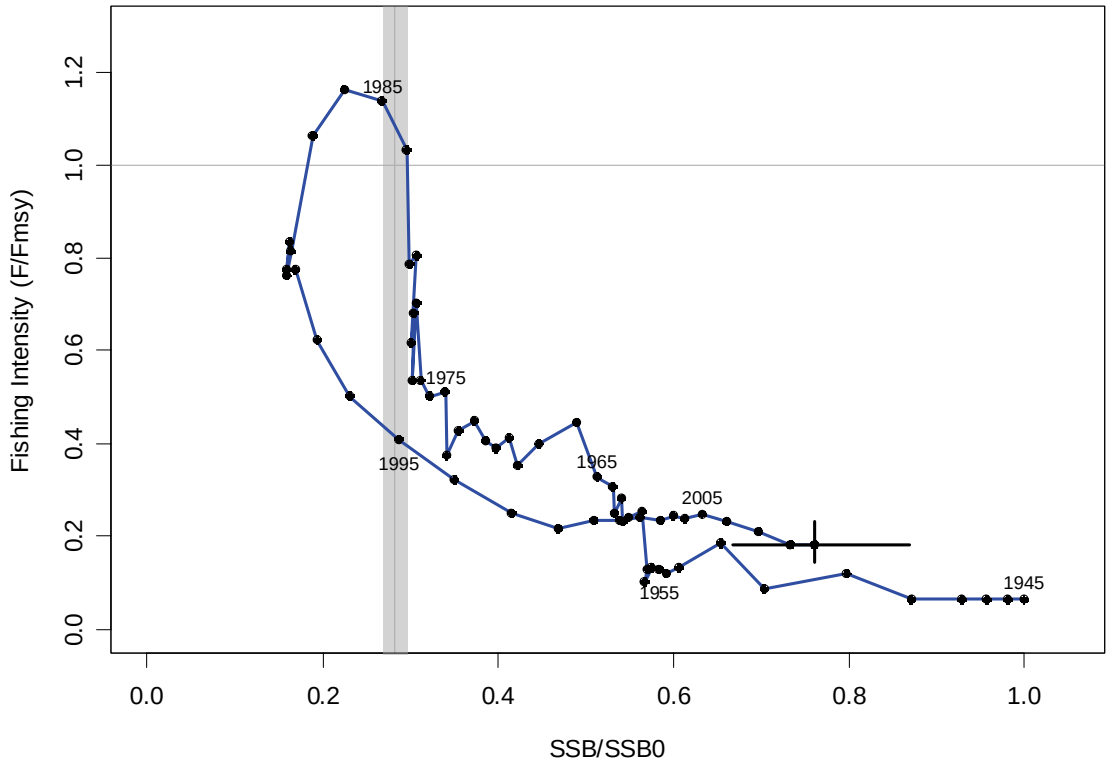


Figure 16: "Snail trail" that summarises the history of the CRA 5 fishery. The x-axis is the spawning biomass (SSB) as a proportion of B0 (SSB0); the y-axis is the ratio of the fishing intensity (F) relative to Fmsy. Each point is the median of the posterior distributions, and the bars associated with 2009 show the 90% confidence intervals. The vertical reference line shows SSBmsy as a proportion of SSB0, with the grey band indicating the 90% confidence interval. The horizontal reference line is Fmsy.

In 1945 the fishery was near the lower right-hand corner of the plot, in the high biomass/low fishing the intensity region as expected. It climbed towards the low biomass/high intensity region, reaching highest fishing intensity in 1985 and lowest biomass in 1991. After 1991, the fishery moved quite steadily back towards lower fishing intensity and higher biomass. The current biomass on this scale is near that of 1951, and current fishing intensity is near that of 1952.

6.5 CRA 6

This section reports an assessment for *J. edwardsii* for CRA 6 from the CHI stock taken from the 1996 Mid-year Plenary report (Annala & Sullivan 1996).

Alternative methods have been used to assess the CHI stock. These include a simple depletion analysis presented to the Working Group in previous years and a new production model, which appeared to fit the observed data well. Both models assume a constant level of annual productivity which is independent of the standing stock and thus will not be affected by changes to the level of the standing stock. B_0 was estimated by both models to be about 20 000 t.

6.6 CRA 7 and CRA 8

This section reports assessments for *J. edwardsii* for CRA 7 and CRA 8 from the NSS substock taken from the 2006 Mid-year Plenary report (Ministry of Fisheries 2006).

New catch histories for each stock were developed within the Working Group and also various other assumptions agreed for recreational and customary catches. Input data to the model included tag recoveries for growth rates, standardised CPUE from 1979-2006, historical catch rate data from 1963-73 and length frequency data from commercial catches (log book and catch sampling data). The start date for the model was set at 1976 to improve the behaviour of the model (to overcome problems with the Hessian matrices).

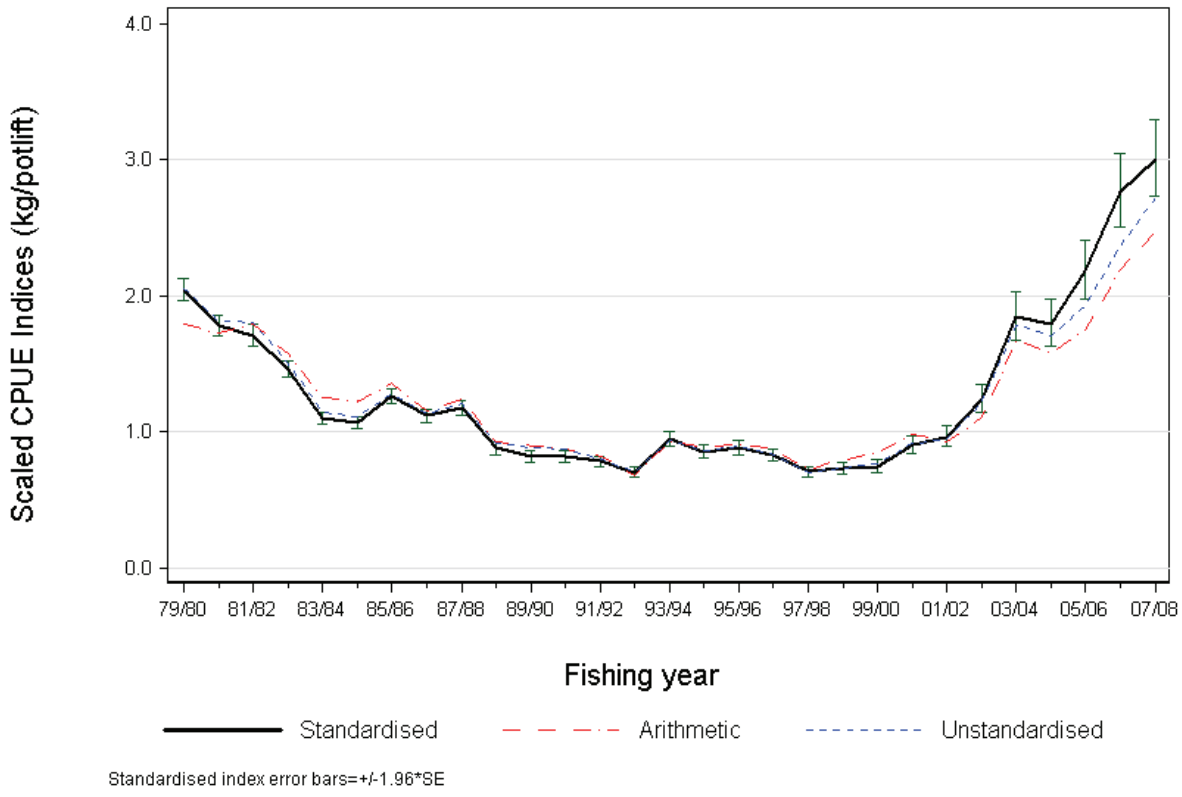


Figure 17: Annual CPUE indices for CRA 8: arithmetic (dashed line), unstandardised (dotted line), and standardised (bold line) ± 2 s.e. 1979–80 to 2007–08. The geometric mean for each series = 1.13 kg/potlift.

The Working Group discussed the results from a proposed basecase and 5 sensitivity trials. The results were generally similar indicating that the model had explored the same general solution in all six runs. However, there were some differences in the indicators between the runs. Overall there appeared to be poor MCMC behaviour for all model runs.

A primary diagnostic is the appearance of the traces, simply the parameter value plotted against sample number. These should be well mixed and should not show a trend through the simulation. In

the proposed basecase MCMC simulation, the *M* parameter shows a jump after about 900 samples from values between 0.02 and 0.03 up to values between 0.04 and 0.07. This problem is also seen in the running median, running percentile and moving mean plots. These should ideally show good stability through the simulation, but diagnostics for the estimated parameters in this run were not good.

Traces for the *M* parameter did not appear to cover the full range of values that are plausible. For example the MCMC only explored values in the range 0.02 to 0.07 while higher values are plausible. These diagnostics suggest that the MCMC is not properly converged, and that the behaviour of *M* is a prime suspect. Most other posteriors appear to be well-formed.

The proposed basecase was not considered acceptable by the Working Group to report as the final assessment for these stocks. However, the Working Group did not consider there was any current sustainability concern with these stocks. Both stocks show increasing CPUE to levels not seen since the 1980s. CPUE in CRA8 in 2006 (Figure 17) was well above the target set for the rebuilt stock (1.9 kg per potlift).

The Working Group agreed that as no management measures were required in CRA 7 and CRA 8 for 2007, the assessment did not need to be completed before the planned November Plenary meeting (this meeting was subsequently cancelled). However, to allow the management strategy evaluation to be completed for CRA 7 and CRA 8 in 2007 an agreed basecase model will be required early next year. Alternative parameterisations or methodology may be needed to form a base operating model suitable for management strategy evaluation.

7. YIELD ESTIMATES

7.1 Estimation of Maximum Constant Yield (MCY)

***Jasus edwardsii*, all stocks**

MCY was not estimated.

***Sagmariasus verreauxi*, PHC stock**

MCY was estimated using the equation $MCY = cY_{av}$ (Method 4). Mean annual landings for 1979–96 were 20.0 t. The best estimate of *M* is 0.1, so the value of *c* was set at 0.9.

$$MCY = cY_{av} = 0.9 * 20 = 18 \text{ t}$$

It is not possible to assess the level of risk to the stock of harvesting the population at the estimated MCY value.

7.2 Estimation of Current Annual Yield (CAY)

***Jasus edwardsii*, all stocks**

CAY was not estimated for any stock.

***Sagmariasus verreauxi*, PHC stock**

CAY was not estimated because no biomass estimates are available for this stock.

8. STATUS OF THE STOCKS

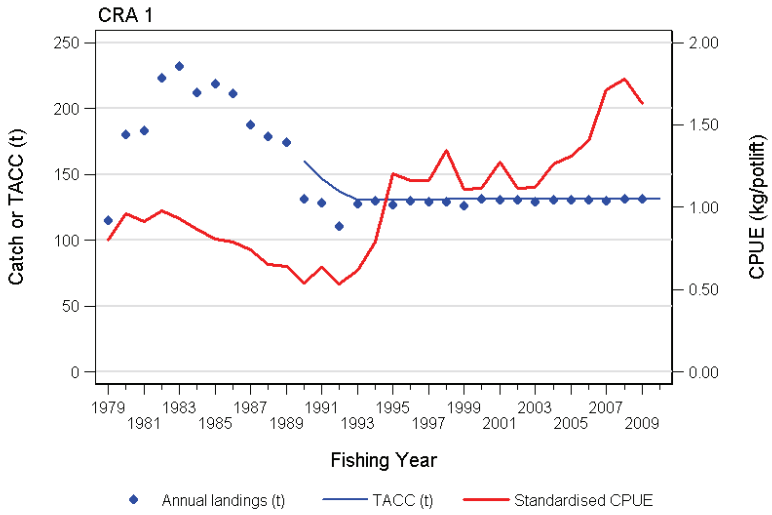
8.1 *Jasus edwardsii*, NSN substock

CRA 1 Northland

Stock Status	
Year of Most Recent Assessment	2002
Assessment Runs Presented	Base case and 2 sensitivity runs

Reference Point	- *Bref*: mean of beginning AW vulnerable biomass for the period 1979-88
Status in relation to Target	Biomass in 2002 was 150% of reference biomass
Status in relation to Limits	Unknown

Historical Stock Status Trajectory and Current Status



Annual landings, TACC and standardised CPUE for CRA1 from 1979 to 2009.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Standardised CPUE increased steadily from 2003 to 2008, but dropped in 2009
Recent Trend in Fishing Mortality or Proxy	Unknown
Other Abundance Indices	
Trends in Other Relevant Indicators or Variables	

Projections and Prognosis	
Stock Projections or Prognosis	5 year forward projections under 2002 levels of commercial, customary, non-commercial and illegal catches showed that the stock would remain at a similar level.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 1 Quantitative Assessment model	
Assessment Method	Bayesian length based model	
Main data inputs	CPUE, length frequency data, tagging data	
Period of Assessment	Latest assessment: 2002	Next assessment: Unknown
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty	Non-commercial catch	

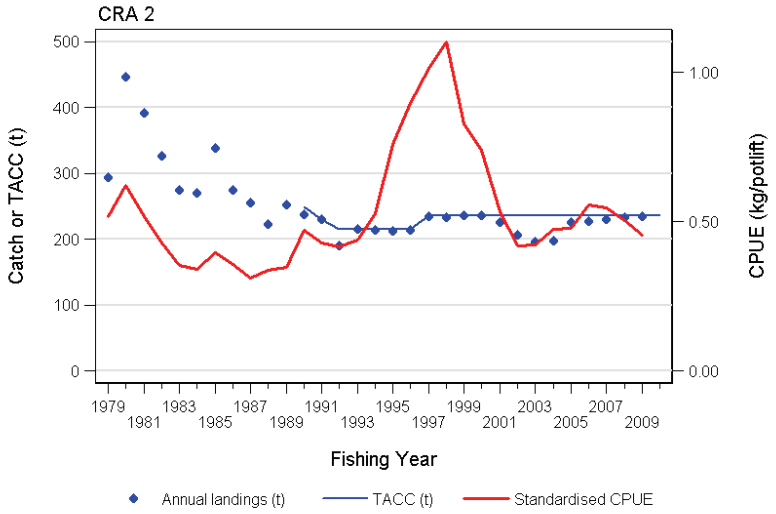
Qualifying Comments

Recent developments in stock status
CPUE in the last 3 years is well above the 2002 level, and the stock is well above the target (reference) level.

Fishery Interactions

CRA 2 Bay of Plenty

Stock Status		
Year of Most Recent Assessment	2002	
Assessment Runs Presented	Base case and 2 sensitivity runs	
Reference Point	- *Bref*: mean of beginning AW vulnerable biomass for the period 1979-88	
Status in relation to Target	Biomass in 2002 was 150% of reference biomass	
Status in relation to Limits	Unknown	
Historical Stock Status Trajectory and Current Status		



Annual landings, TACC and standardised CPUE for CRA2 from 1979 to 2009.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Standardised CPUE dropped to below 0.5 kg/potlift from the peak year in 1997. Since then CPUE has remained relatively constant around this level but has declined in the most recent 2-3 years
Recent Trend in Fishing Mortality or Proxy	Unknown
Other Abundance Indices	
Trends in Other Relevant Indicators or Variables	

Projections and Prognosis		
Stock Projections or Prognosis	5 year forward projections under 2002 levels of commercial, customary, non-commercial and illegal catches showed that the stock would remain at a similar level.	
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown	
Assessment Methodology		
Assessment Type	Level 1 Quantitative Assessment model	
Assessment Method	Bayesian length based model	
Main data inputs	CPUE, length frequency data, tagging data	
Period of Assessment	Latest assessment: 2002	Next assessment: Unknown
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty	Non-commercial catch	

Qualifying Comments
Recent developments in stock status
CPUE increased from 2002 to 2007 but has since decreased back to the 2002 level.

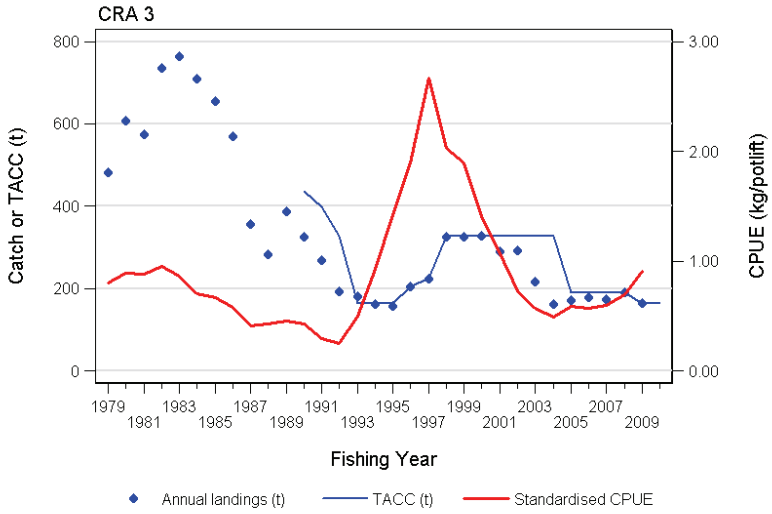
Fishery Interactions

8.2 *Jasus edwardsii*, NSC substock

CRA 3 Gisborne

Stock Status	
Year of Most Recent Assessment	2008
Assessment Runs Presented	Base case and 13 MPD sensitivity runs
Reference Point	B_{MSY}
Status in relation to Target	Biomass in 2008 was about half B_{MSY}, with a 0% probability of being above B_{MSY}
Status in relation to Limits	Biomass in 2008 was 11% above B_{min}, with an 82% probability of being above B_{min}

Historical Stock Status Trajectory and Current Status



Annual landings, TACC and standardised CPUE for CRA3 from 1979 to 2009.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass declined steadily from 1997 to 2003 and may now be increasing after several years of little change
Recent Trend in Fishing Mortality or Proxy	
Other Abundance Indices	
Trends in Other Relevant Indicators or Variables	

Projections and Prognosis	
Stock Projections or Prognosis	5 year forward projections under 2008 levels of commercial, customary, non-commercial and illegal catches showed that the stock would decrease by 25%.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 1 Quantitative Assessment model	
Assessment Method	Multi-stock length based model (Haist et al 2009)	
Main data inputs	CPUE, length frequency, tagging data	
Period of Assessment	Latest assessment: 2008	Next assessment: Unknown
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty	Future recruitment and growth rate	

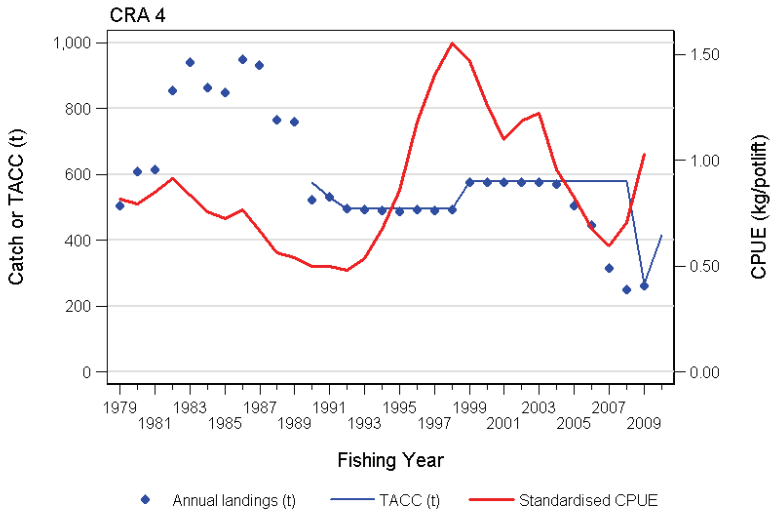
Qualifying Comments
The quality of the 2008 Markov chain–Monte Carlo simulations was not high. The running quantile plots for many estimated parameters showed a drift through the run, suggesting poor convergence, and a trend to move well away from the MPD estimate.

Recent developments in stock status
CPUE has been increasing since 2004. In 2010 the management procedure for CRA 3 proposed that the TAC would remain at 293 t because the CPUE remains above the 0.75 kg/potlift threshold and below the 1.08 kg/potlift threshold.
Fishery Interactions

CRA 4 Wairarapa – Hawke Bay

Stock Status	
Year of Most Recent Assessment	2005
Assessment Runs Presented	Base case and 3 MCMC sensitivity runs
Reference Point	- *Bref*: mean of beginning AW vulnerable biomass for the period 1979-88
Status in relation to Target	Biomass in 2005 was about 1.8 times the reference level
Status in relation to Limits	Unknown

Historical Stock Status Trajectory and Current Status



Annual landings, TACC and standardised CPUE for CRA4 from 1979 to 2009.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass decreased in two steps from a peak in 1997 to a low in 2007 but has increased in the two most recent years
Recent Trend in Fishing Mortality or Proxy	
Other Abundance Indices	

Trends in Other Relevant Indicators or Variables	

Projections and Prognosis	
Stock Projections or Prognosis	5 year forward projections under 2005 levels of commercial, customary, non-commercial and illegal catches showed that the stock would remain at a similar level.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 1 Quantitative Assessment model	
Assessment Method	Bayesian length based model	
Main data inputs	CPUE, length frequency, tagging data	
Period of Assessment	Latest assessment: 2005	Next assessment: Unknown
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty		

Qualifying Comments

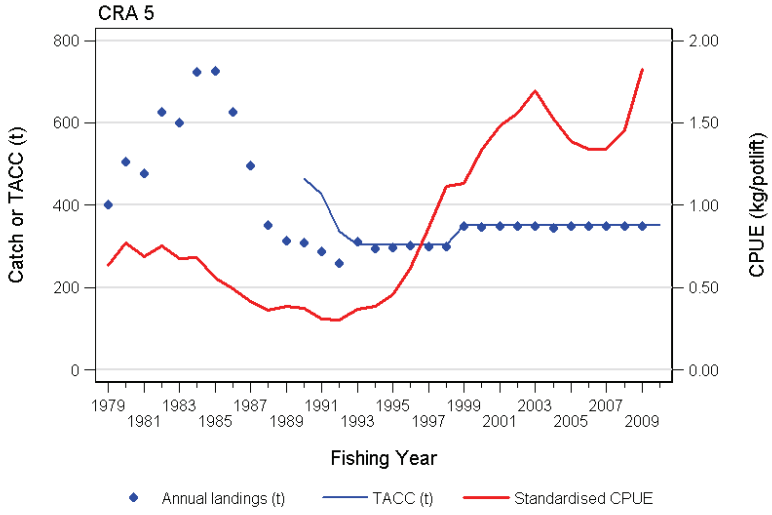
Recent developments in stock status
CPUE has increased in the last 2 years. In 2010 the management procedure for CRA 4 proposed a TACC of 466.9 t based on the most recent AW CPUE estimate of 0.857 kg/pot.

Fishery Interactions

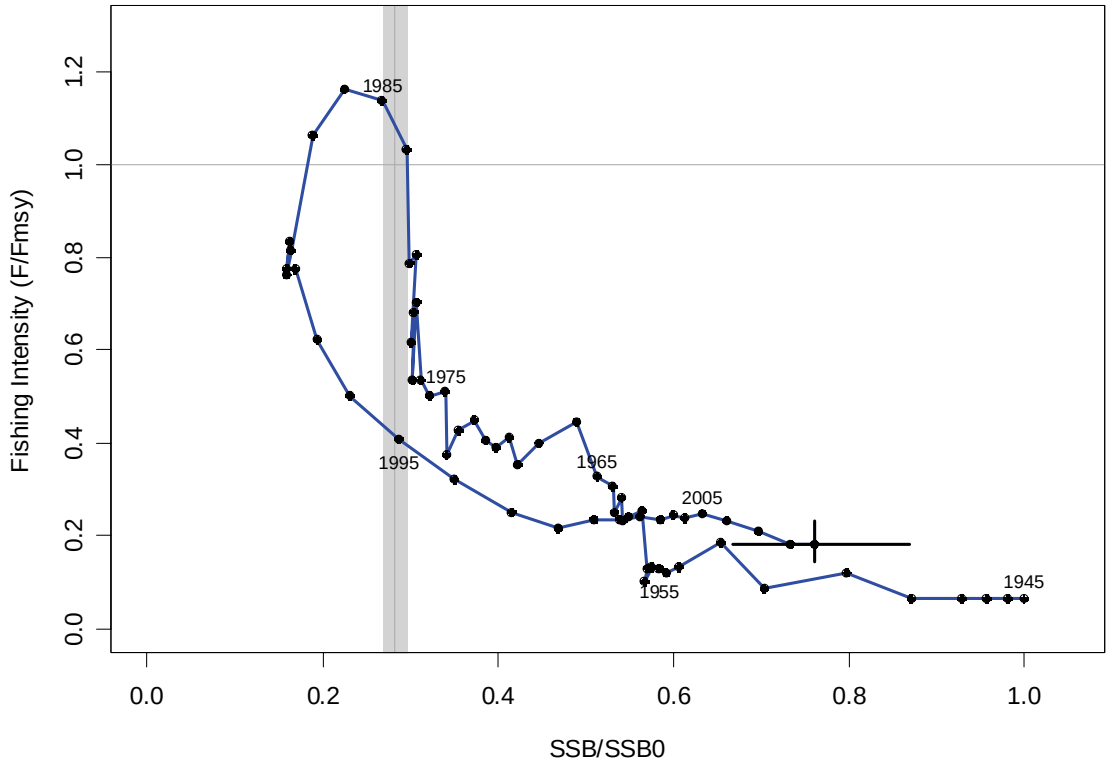
CRA 5

Stock Status	
Year of Most Recent Assessment	2010
Assessment Runs Presented	Base case
Reference Points	- *Bref*: mean of beginning AW vulnerable biomass for the period 1979-88 - *SSBmsy*: mature female biomass associated with B_{MSY} - Soft limit: 0.2 *SSB0* - Hard limit: 0.1 *SSB0*
Status in relation to Target	*Bcurrent* = 3.0 *Bref* (vulnerable AW biomass) *SSBcurrent* = 4.6 SS*Bmsy*
Status in relation to Limits	*P(SSBcurr*<0.2 *SSB0)* = 0 *P(SSBcurr*<0.1 *SSB0)* = 0

Historical Stock Status Trajectory and Current Status



Annual landings, TACC and standardised CPUE for CRA5 from 1979 to 2009.



"Snail trail" that summarises the history of the CRA 5 fishery. The x-axis is the spawning biomass (*SSB*) as a proportion of *B0 (SSB0)*; the y-axis is the ratio of the fishing intensity (*F*) relative to *Fmsy*. Each point is the median of the posterior distributions, and the bars associated with 2009 show the 90% confidence intervals. The vertical reference line shows *SSBmsy* as a proportion of *SSB0*, with the grey band indicating the 90% confidence interval. The horizontal reference line is *Fmsy*.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE is at the highest level in the 31 year series after a short period of decline in the mid-2000s
Recent Trend in Fishing Mortality or Proxy	Fishing mortality declined substantially after CRA 5 entered the QMS, and is currently at its lowest level. Current fishing intensity is equivalent to the level observed in 1952.
Other Abundance Indices	None
Trends in Other Relevant	The 2009 puerulus (settlement) index is about 1/3 average.

Indicators or Variables	However, average settlement over the past 10 years has been near the long-term average

Projections and Prognosis		
Stock Projections or Prognosis	5 year forward projections under 2009 levels of commercial, customary, illegal catches and 2 alternative recreational catches catch levels (155 t and 112 t) showed that the biomass would decrease, but remain well above the target reference levels.	
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: $P(SSBproj<0.2SSB0) = 0$ Hard Limit: $P(SSBproj<0.1SSB0) = 0$	
Assessment Methodology		
Assessment Type	Level 1 Quantitative Assessment model	
Assessment Method	Bayesian length based model	
Main data inputs	CPUE, length frequency, tagging data, puerulus data	
Period of Assessment	Latest assessment: 2010	Next assessment: Unknown
Changes to Model Structure and Assumptions	Revised growth model, addition of puerulus data	
Major Sources of Uncertainty	Level of non-commercial catches, illegal catches, modelling of growth, estimation of productivity	

Qualifying Comments
A management procedure has also been developed that may be used to manage the fishery in the future.

Recent developments in stock status
Stock size is currently well above all reference points and fishing mortality appears to be low

Fishery Interactions
Potting is the main method of targeting rock lobster and is usually assumed to have very little direct impact on non-target species. For all QMAs, the most frequently reported incidental species caught are, in decreasing order of catch across all stocks: octopus, conger eel, blue cod, trumpeter, sea perch, red cod, butterfish and leatherjackets. However, these generally comprise less than 10% of the rock lobster catch.

8.3 *Jasus edwardsii*, NSS substock

In 2006, CRA 7 and CRA 8 were modelled simultaneously as separate stocks within a new multi-stock model. The assessment was not finalised in the time available; however, both stocks showed increasing CPUE to levels not seen since the 1980s. CPUE in CRA8 in 2006 was well above the target set for the rebuilt stock (1.9 kg per potlift). This indicated that it was time to develop a management strategy designed to maintain stock biomass, and this was done in 2007.

In 2010 the 2007 management procedure for CRA 7 proposed a decrease in the TAC for CRA 7 to 95.7t for the 2011-12 fishing year. For CRA 8 the management procedure proposed an increase in TAC to 1053 t.

8.4 *Jasus edwardsii*, CHI stock

The most recent stock assessment for CRA 6 was done in 1996, using catches and abundance indices current up to the 1995–96 fishing year. The status of this stock is uncertain. Catches were less than the TACC 1990–91 to 2004–05, but have been within 10 t of the TACC since then. CPUE showed a declining trend from 1979–80 to 1997–98, but has then increased in two stages to levels higher than seen in the early 1990s. These observations suggest a stable or increasing standing stock after an initial fishing down period. However, size frequency distributions in the lobster catch had not changed when they were examined in the mid 1990s, with a continuing high frequency of large lobsters. Large lobsters would have been expected to disappear from a stock declining under fishing pressure. This apparent discrepancy could be caused by immigration of

large lobsters into the area being fished. The models investigated assume a constant level of annual productivity which is independent of the standing stock.

Commercial removals in the 2009−10 fishing year (345 t) were within the range of estimates for MCY (300−380 t), and close to the current TACC (360 t). The current TAC (370 t) lies within the range of the estimated MCY.

8.5 *Sagmariasus verreauxi*, PHC stock

The status of this stock is unknown.

Table 39: Summary of yield estimates (t), TACCs and TACs (t), and reported 2007-08 commercial landings. The yield estimates for CRA 6 are the range of yield estimates from a simple production model. ('–', not available).

Fishstock	QMA	Yield Estimate	2009–10 TACC	2009–10 Landings	2010–11 TACC	2010–11 TAC
CRA 1	Northland	–	131.1	130.9	131.1	–
CRA 2	Bay of Plenty	–	236.1	235.0	236.1	452.6
CRA 3	Gisborne	–	164.0	164.0	164.0	293.0
CRA 4	Wairarapa–Hawke Bay	–	266.0	262.0	415.6	610.6
CRA 5	Canterbury–Marlborough	–	350.0	349.9	350.0	467.0
CRA 6	Chatham Islands	300–380	360.0	344.8	360.0	370.0
CRA 7	Otago	–	189.0	136.5	84.5	104.5
CRA 8	Southern	–	1 019.0	1 018.3	1 019.0	1 110.0
CRA 9	Westland–Taranaki	–	47.0	46.6	47.0	–
CRA 10	Kermadec	–	0.0	0.0	0.0	–
Total			2 762.2	2 688.0	2 807.3	3 407.7
PHC 1	All QMAs	18	40.3	36.3	40.3	–

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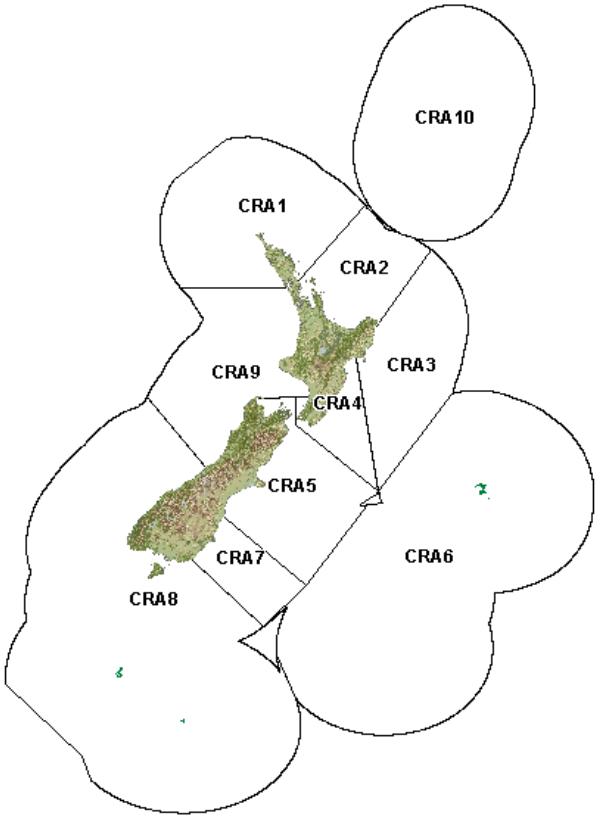
ANNEX 3: INITIAL POSITION PAPER (IPP) FOR STATUTORY CONSULTATION

NEW ZEALAND ROCK LOBSTER FISHERIES

PUBLIC CONSULTATION DOCUMENT ON PROPOSALS TO REVIEW SUSTAINABILITY MEASURES AND OTHER MANAGEMENT CONTROLS FOR 1 APRIL 2011



13 DECEMBER 2010

CONTENTS

1. INTRODUCTION

PURPOSE OF THIS DOCUMENT

1. The purpose of this document is to commence a consultation process on behalf of the Minister of Fisheries on proposals to vary sustainability measures and other management controls for rock lobster fisheries for the 2011-12 fishing year.

2. There are three initial advice papers in this document that set out the National Rock Lobster Management Group's (NRLMG's) initial advice on proposals to:

    a) use new management procedures to guide Total Allowable Catch (TAC) setting in the CRA 5 (Canterbury/Marlborough) and CRA 7 (Otago) spiny rock lobster stocks

    b) set TACs and allowances for the CRA 4 (Wellington/Hawkes Bay), CRA 5 (Canterbury/ Marlborough), CRA 7 (Otago) and CRA 8 (Southern) spiny rock lobster stocks

    c) review deemed value rates for spiny and packhorse rock lobster.

3. The Ministry of Fisheries (MFish) welcomes information and comments from tangata whenua, fishery stakeholders and other interested parties on the proposals.

4. Stakeholders are requested to forward their comments on the proposals by **5pm Wednesday, 2 February 2011**.

5. Submissions should be sent directly to:

    Trudie Macfarlane
    Ministry of Fisheries
    P O Box 1020
    Wellington

    or emailed to trudie.macfarlane@fish.govt.nz

TERMINOLOGY IN THE DOCUMENT

Management Procedures

6. A management procedure is a tool used to guide the setting of catch limits. Management procedures are becoming more widely used, especially in South Africa, Australia, Europe, North America, and in New Zealand. A management procedure:

    a) specifies what data will be used to make catch limit decisions;

    b) specifies how the data will be collected and analysed;

    c) contains a harvest control rule (a mathematical equation that determines what the specific output of the procedure will be, such as the exact TAC or Total Allowable Commercial Catch (TACC)); and

    d) has been extensively simulation-tested using an operating model that is a model of the fishery system being managed.

7. Under a management procedure approach, agreement is obtained among managers and stakeholders before the procedure is implemented: they agree about the data inputs, the way the inputs will be treated to make inferences, the harvest control rule and the period for which the management procedure will be used. Extensive simulation testing of the procedure is undertaken to ensure it will deliver the desired outcomes.

8. The advantages of a management procedure approach, over the conventional approach of periodic stock assessments followed by decision making, are:

   a) the process leads to explicit definition of management objectives;

   b) all participants in the fishery can become involved in the choice of procedure;

   c) uncertainty in all facets of the assessment and management process can be addressed;

   d) greater certainty of achieving outcomes is provided;

   e) management procedures reduce the need for regular stock assessments, freeing resources for other research; and

   f) the process is more understandable to fishers than the conventional approach.

Sustainability Indicators (Bmsy, Bref, Bmin)

9. The NRLMG uses sustainability indicators to report on stock health and to evaluate the effectiveness of management options. For most rock lobster stocks, performance is reported against sustainability reference levels and a minimum stock size.

10. Three sustainability indicators are relevant to evaluation of the proposals presented in this paper:

    a) The statutory reference level, ***Bmsy***. TACs for rock lobster stocks are set under section 13 of the Act. Section 13 requires the Minister to set TACs for rock lobster stocks that move the stocks to, or maintain the stocks at, a level at or above *Bmsy*, or that is not inconsistent with this objective.

    b) The proxy reference level, ***Bref***. When a *Bmsy* estimate is absent or unreliable, alternative proxy reference levels are used. Proxy reference levels are a way of setting a TAC that is not inconsistent with the objective of maintaining a stock at or above, or moving the stock towards a level that can maintain the maximum sustainable yield. This "not inconsistent" approach is set out in section 13(2A) of the Act where the Minister considers that current biomass or *Bmsy* cannot be estimated reliably using best information. *Bref* is generally a stock size at or above the stock size associated with a period in the fishery that showed good productivity and was demonstrably safe.

    c) The minimum stock size, ***Bmin***. *Bmin* is either the stock size associated with lowest abundance in the observed history of the fishery or *½ Bref*.

11. For all these indicators, the stock size is measured in terms of vulnerable biomass. "Vulnerable biomass" is the total quantity of lobsters available to the fishery (ie, it does not include lobsters that cannot be harvested such as undersize lobsters and berried female lobsters).

12. The NRLMG's management goal is for all rock lobster fisheries to be managed and maintained at or above the assessed and agreed reference levels, using a comprehensive approach that recognises a range of customary Maori, amateur, commercial and environmental concerns and

benefits. In order to be consistent with management goal the NRLMG has specified a desired performance in relation to sustainability indicators, which is:

a) a stock size above the agreed proxy (*Bref*) with at least 50% of the time

b) a stock size that remains above the minimum (*Bmin*) with 90% probability; and

c) a spawning stock size that remains above 20% of its unfished level with high probability.

13. Extensive simulation-testing based on operating models of the stocks and associated fisheries suggest that all the management procedures discussed in this paper achieve the desired performance in relation to the sustainability indicators.

The Harvest Strategy Standard

14. In October 2008, MFish released the Harvest Strategy standard for New Zealand fisheries (the HSS), which specifies performance standards for Quota Management System species. The NRLMG considers the management procedures previously agreed for CRA 4, CRA 7 and CRA 8, and the proposed new management procedure for CRA 5 and CRA 7, to be consistent with the HSS.

15. The Guidelines for Harvest Strategy Standards (MFish 2008) describe the *Bref* concept as follows: "Conceptual proxies for BMSY, FMSY and MSY are qualitative surrogates that can be used in the absence of adequate information to directly estimate these reference points themselves. The conceptual interpretation embraces the spirit and intent of section 13 of the Act. It can be used in cases where there is insufficient information to estimate BMSY, FMSY or MSY explicitly, or where such estimates may be unreliable because, for example, there is little or nothing known about the stock recruitment relationship. Conceptual BMSY: In cases where the relationship between CPUE and abundance can be assumed to be more or less proportional, or where some other form of relationship has been derived from data, it may be reasonable to select an appropriate historical period when both CPUE and catches were relatively high and to use this CPUE level as a target. *The best example in current use in New Zealand is that for rock lobster*." [emphasis added]

ROCK LOBSTER FISHERIES

16. The spiny rock lobster (*Jasus edwardsii*; koura) has always been important to Maori and has supported increasingly important recreational and commercial fisheries. Rock lobsters support one of the country's oldest commercial fisheries, and are one of the seafood industry's top export earners. The packhorse rock lobster makes up less that 1% of commercial rock lobster landings. Estimates of non-commercial catches are unknown but non-commercial fishers are known to target packhorse rock lobster to the North of New Zealand.

17. For information on fishery and biological characteristics of rock lobster refer to sections in the 2010 NRLMG Annual Report.

2. PROPOSAL TO USE NEW MANAGEMENT PROCEDURES TO GUIDE TAC SETTING IN CRA 5 AND CRA 7

SUMMARY

18. The National Rock Lobster Management Group (NRLMG) proposes to use new management procedures in CRA 5 (Canterbury/Marlborough) and CRA 7 (Otago) rock lobster fisheries to guide Total Allowable Catch (TAC) setting from the 2011-12 fishing year onwards, beginning 1 April 2011.

19. The following management options are proposed for CRA 5 and CRA 7 in this paper:

Stock	Option	Description
CRA 5	**Option 1**	Agree to use the proposed new CRA 5 Management Procedure to guide TAC setting in CRA 5
	Option 2	Continue to use periodic stock assessments to guide TAC setting in CRA 5 (*status quo*)
CRA 7	**Option 1**	Agree to use the proposed revised CRA 7 Management Procedure to guide TAC setting in CRA 7
	Option 2	Continue to use the current CRA 7 Management Procedure to guide TAC setting in CRA 7 (*status quo*)

20. A central consideration when choosing whether or not to use a management procedure to guide TAC setting in a fishery is whether the procedure enables the Minister of Fisheries to set a TAC that complies with section 13 of the Fisheries Act 1996 (the Act). Section 13 requires the Minister to set a TAC that moves the stock to, or maintains the stock at, a size at or above a level that can produce the maximum sustainable yield (ie, *Bmsy*) or at a level that is not inconsistent with this objective.

21. The NRLMG is confident that application of the proposed new CRA 5 management procedure and the proposed revised CRA 7 management procedure will ensure that the Minister sets a TAC that has a high probability of maintaining stock levels at or above *Bmsy* or the agreed proxy (ie, *Bref*). The use of management procedures to guide TAC setting improves overall sustainability outcomes by being responsive to changes in abundance in the stock.

22. Simulation-testing of the CRA 5 and CRA 7 management procedures also indicates that, as a result of maintaining the stocks well above sustainability reference levels (*Bref* and *Bmsy*), application of the management procedures would maintain or improve abundance, and hence would maintain or improve the current utilisation benefits of the fisheries for all sectors over the medium to long term.

23. With respect to CRA 7, the NRLMG advises that the main distinguishing factors between the current and proposed revised CRA 7 management procedures are improved stability in the fishery, less frequent and disruptive TAC changes and a resulting increase in predicted stock biomass levels under the revised management procedure (Option 1). This will, in turn, result in more stability and greater social, cultural and economic benefits. Option 1 is preferred by the

NRLMG and the CRA 7 rock lobster fisheries commercial stakeholder organisation (known as CRAMAC 7)

RATIONALE FOR THE USE OF MANAGEMENT PROCEDURES

24. Management procedures are a tool used to guide the setting of catch limits and specify how management changes will be made in response to changes in specified fishery data. The management procedure approach provides greater certainty of achieving management outcomes for a stock over the conventional approach of periodic stock assessments followed by decision-making; this benefits all sectors and those involved in fisheries management decision-making for rock lobster.

25. Management procedures are in place for several New Zealand rock lobster fisheries. Agreed management procedures are currently in place for CRA 3 (Gisborne), CRA 4 (Wellington/Hawkes Bay), CRA 7 (Otago) and CRA 8 (Southern) rock lobster fisheries and have been used by the Minister to guide statutory TAC setting in these fisheries for varying amounts of time. The oldest example of the use of management procedures is in CRA 7 and CRA 8, where they have been successfully used to guide TAC setting since 1996, first to rebuild the stocks and then to maintain them above reference levels with high probability.

REASONS FOR NEW MANAGEMENT PROCEDURES

26. New management procedures for CRA 5 and CRA 7 were developed for different reasons during 2010.

27. In 2009, the CRA 5 rock lobster fisheries commercial stakeholder organisation (CRAMAC 5) adopted a voluntary procedure to shelve annual catch entitlement (ACE) when catch per unit effort (CPUE) fell below a specified threshold. The rule has not been triggered, but CRAMAC 5 wanted a mechanism which offered the prospect of future Total Allowable Commercial Catch (TACC) increases if stock abundance continued to increase but were not willing to risk moving away from the level of CPUE that has been protected by the voluntary management procedure. The NRLMG agreed that a management procedure should be developed for CRA 5 in 2010 to replace this voluntary shelving rule with a formalised management procedure which has been tested to maintain the CRA 5 stock above reference levels.

28. In 2010, CRAMAC 7 requested a review of the current CRA 7 management procedure to obtain more stability in the TAC. The NRLMG agreed that a revised CRA 7 management procedure should be developed in 2010.

RELEVANT STATUTORY CONSIDERATIONS

29. A central consideration when choosing whether or not to use a management procedure to guide TAC setting in a fishery is whether the procedure enables the Minister to set a TAC that complies with section 13 of the Act. Section 13 requires the Minister to set a TAC that moves the stock to, or maintains the stock at, a size at or above *Bmsy* or at a level that is not inconsistent with this objective.

30. The NRLMG is confident that application of proposed new CRA 5 management procedure and application of either the agreed or proposed revised CRA 7 management procedures will ensure that the Minister sets a TAC that has a high probability of maintaining stock levels at or above *Bmsy* or the agreed proxy (ie, *Bref*).

31. A full assessment of the management options against key statutory criteria is carried out in Paper 2: *Proposals to set TACs and allowances for CRA 4, CRA 5, CRA 7 and CRA 8*.

PROPOSAL TO USE A NEW MANAGEMENT PROCEDURE TO GUIDE TAC SETTING IN THE CRA 5 ROCK LOBSTER FISHERY

Summary of CRA 5 Management Options

32. The NRLMG is seeking comments on two management options for CRA 5.

33. Under **Option 1**, the Minister would use the CRA 5 Management Procedure to guide statutory TAC setting for CRA 5. The specifications of the CRA 5 Management Procedure are described in detail in Attachment 2.

34. The Minister would be guided by the operation of the management Procedure when setting the TAC for CRA 5 until the 2016-17 fishing year. During 2015, the management procedure would be reviewed.

35. Under **Option 2**, periodic stock assessments (which are relatively infrequent because of resource constraints) would continue to guide TAC setting for CRA 5. Seasonal CPUE information would be used to monitor stock abundance between stock assessments.

36. A stock assessment was conducted for CRA 5 in 2010 and could be used to inform TAC setting in this fishery if Option 1 is not suitable.

Analysis of Management Options for CRA 5

37. An analysis of the methods proposed for the Minister to use to guide TAC setting in CRA 5 is set out below.

Option 1 – Agree to use the CRA 5 Management Procedure to guide TAC setting in CRA 5

38. Under Option 1, it is proposed that the Minister would use the CRA 5 Management Procedure to guide statutory TAC setting for CRA 5 from the 2011-12 fishing year onwards, beginning 1 April 2011.

Stock Sustainability

39. Use of the CRA 5 management procedure to guide TAC setting in CRA 5 is unlikely to pose any risk to stock sustainability: simulation-testing of the procedure shows it to be very safe with respect to sustainability indicators. Ongoing application of the CRA 5 Management Procedure is expected to:

    a) Maintain the stock above *Bmsy*, *Bref* and *Bmin* with greater than 95% probability;

    b) Maintain mean biomass at about 2.3 times *Bref*, which is greater than *Bmsy* for CRA 5; and

    c) Maintain spawning stock biomass well above 20% of its unfished level, which is consistent with the MFish Harvest Strategy Standard.

40. The NRLMG is confident that use of the CRA 5 management procedure will ensure that the statutory objective of managing the stock at or above *Bmsy* is met. This is because the management procedure is expected to maintain the stock well above *Bref* (and *Bmsy*).

41. The use of the CRA 5 management procedure is also safe from the standpoint of stock sustainability because the management procedure:

a) Was chosen from a set of management procedures that were evaluated for performance against sustainability criteria;

b) Has been tested using a model of the CRA 5 fishery based on the 2010 CRA 5 stock assessment model, which was accepted by the MFish Plenary in 2010;

c) Has been tested for robustness to uncertainties, including uncertainties in recruitment, in the level of non-commercial catches and in the stock assessment results. The procedure was robust to these uncertainties and desired performance against the sustainability indicators was maintained; and

d) Is responsive to changes in abundance in the stock.

Utilisation Benefits

42. Simulation-testing of the CRA 5 Management Procedure indicates that, as well as maintaining the stock well above reference levels (*Bref* and *Bmsy*), the management procedure would maintain the current utilisation benefits of the fishery for all sectors over the medium to long terms by maintaining the stock well above reference levels.

43. The CRA 5 management procedure delivers a TAC result that consists of three separate components: a component for the TACC, a component for recreational catch and a component for non-size limited catches (customary and illegal fishing).

44. The effect of the proposed CRA 5 management procedure on the costs and benefits conferred on any one sector would depend on allocation decisions. An assessment of how current non-commercial allowances should be adjusted is discussed in Paper 2 – *Proposal to set TACs and allowances for CRA 4, CRA 5, CRA 7 and CRA 8.*

Credibility and Acceptance

45. The CRA 5 Management Procedure already has a very high degree of acceptance and support among CRAMAC 5, partly because the procedure incorporates key elements of the voluntary ACE shelving rule that they have used since 2009. The management procedure is supported by the NRLMG's recreational and customary members; the NRLMG is seeking feedback from wider recreational and customary Maori fishery participants.

46. Agreeing to use the CRA 5 management procedure should reduce the frequency of stock assessments, free up resources for other research and potentially reduce the cost to commercial stakeholders.

Option 2 – Continue to use Periodic Stock Assessments to Guide TAC Setting in CRA 5

47. Under Option 2, periodic stock assessments would continue to guide TAC setting for CRA 5 (the *status quo*). Compared with Option 1, using periodic stock assessments to guide TAC setting for CRA 5:

a) is less responsive to observed changes in stock abundance in the fishery

b) provides lesser certainty of achieving desired sustainability and utilisation outcomes

c) may result in less cost efficient management of the fishery.

CRA 5 Initial Position

48. Based on best available information and the analysis set out above, the NRLMG's preferred option is **Option 1**: agree to use the CRA 5 management procedure to guide TAC setting in CRA 5 from the 2011-12 fishing year, beginning 1 April 2011.

PROPOSAL TO USE A NEW MANAGEMENT PROCEDURE TO GUIDE TAC SETTING IN THE CRA 7 ROCK LOBSTER FISHERY

Summary of CRA 7 Management Options

49. The NRLMG is seeking comments on two management options for CRA 7.

50. Under **Option 1**, the Minister would use the proposed revised CRA 7 Management Procedure to guide statutory TAC setting for CRA 7. It is proposed that the Minister would be guided by the operation of the revised management procedure when setting the TAC for CRA 7 until the 2012-13 fishing year.

51. Under **Option 2**, the Minister would continue to use the current CRA 7 Management Procedure to guide statutory TAC setting for CRA 7. The Minister agreed to use the current CRA 7 Management Procedure in March 2008 to guide TAC setting in the fishery until the 2012-13 fishing year.

52. Specifications of both the current and proposed revised CRA 7 management procedures are described in detail in Attachment 3.

Analysis of Management Options for CRA 7

53. An analysis of the two different management procedure options the Minister could use to guide TAC setting in CRA 7 is set out below.

CRAMAC 7's concerns with the current CRA 7 management procedure

54. Normally, management procedures are reviewed after five years. However, CRAMAC 7 requested an earlier review of the current CRA 7 management procedure because the rule has resulted in frequent large changes to the TAC.

55. CRAMAC 7 have now indicated they would prefer a management procedure with more stability, fewer changes and less dramatic changes in the TAC.

Comparison of the current and proposed revised CRA 7 management procedures

56. The NRLMG is confident that use of either CRA 7 management procedure will ensure that the Minister sets a TAC that has a high probability of achieving the statutory objective of managing the stock at or above *Bmsy*. This is because both management procedures are expected to maintain the stock well above *Bmsy* and the agreed proxy for *Bmsy*, *Bref*.

57. Both management procedures are safe from the standpoint of stock sustainability because they:

a) were chosen from a set of management procedures that were evaluated for performance against sustainability criteria;

b) have been tested using a model of the CRA 7 fishery based on the 2006 CRA 7 stock assessment model;

c) have been tested for robustness to uncertainties, including uncertainties in recruitment, in the level of non-commercial catches and in the stock assessment results. The procedure was robust to these uncertainties and desired performance against the sustainability indicators was maintained; and

d) is responsive to changes in abundance in the stock.

58. Because evaluations of either CRA 7 management procedure suggest that the stock would be maintained well above *Bref*, the management procedures would likely increase the current utilisation benefits of the fishery for all sectors over the medium to long terms. The key differences between the two procedures are:

a) The proposed revised CRA 7 management procedure (Option 1) is expected to provide more stability in the TAC, with fewer dramatic changes to the TAC than under the current management procedure (Option 2). This is because the proposed revised CRA 7 management procedure includes a harvesting "plateau" of 120 tonnes when commercial CPUE values are between 1.0 and 2.0 kg/potlift; the current procedure (Option 1) has no plateau.

a) The proposed revised management procedure (Option 1) results in fewer years where stock biomass is predicted to be less than *Bref*. Under Option 1, the stock would stay above *Bref* with 85% probability, whereas under Option 2 (the current procedure) the stock would stay above *Bref* with 80% probability.

b) The proposed revised procedure is expected to have a higher average stock abundance and commercial CPUE than the current procedure (Option 2). Under Option 1, the median average commercial CPUE is predicted to be 1.99kg/potlift, whereas under Option 2 the average CPUE was predicted to be 1.63 kg/potlift.

59. The harvest control rule in both CRA 7 management procedures generates a recommended TAC. Operation of the proposed revised CRA 7 management procedure for the 2011-12 fishing year results in no change to TAC for CRA 7. However, operation of the current CRA 7 management procedure for the 2011-12 fishing year results in a TAC decrease for CRA 7. The impact of the TAC decrease on the fishing sector stakeholders will depend on allocation decisions. Historically, the TACC has been varied to give effect to variations to the TAC, meaning the commercial sector may be most affected by the proposed TAC decrease (this is discussed in Paper 2 – *Proposal to set TACs and allowances for CRA 4, CRA 5, CRA 7 and CRA 8).*

60. The proposed revised CRA 7 Management Procedure has a high degree of acceptance and support among the CRA 7 rock lobster fisheries commercial stakeholder organisation (CRAMAC 7) because they provided initial input into the development of the procedure. The revised procedure is preferred by CRAMAC 7 (in comparison to the current rule, Option 2) because there is more stability in the procedure and there would be fewer dramatic changes in the TACC, which will enable them to stabilise (and potentially increase) their utilisation benefits. The proposed revised procedure is supported by the NRLMG's recreational and customary members; the NRLMG is seeking feedback from wider recreational and customary Maori fishery participants.

CRA 7 Initial Position

61. Based on best available information and the analysis set out above, the NRLMG's preferred option is **Option 1**: agree to use the proposed revised CRA 7 management procedure to guide TAC setting in CRA 7 until the 2012-13 fishing year.

3. PROPOSAL TO SET TACs AND ALLOWANCES FOR CRA 4, CRA 5, CRA 7 AND CRA 8

SUMMARY

62. The National Rock Lobster Management Group (NRLMG) proposes to vary the Total Allowable Catch (TAC) and allowances for CRA 4 (Wellington/Hawkes Bay), CRA 5 (Marlborough/Canterbury), CRA 7 (Otago) and CRA 8 (Southern) rock lobster fisheries for the 2011-12 fishing year, beginning 1 April 2011.

63. The proposals are based on the operation of agreed management procedures for CRA 4 and CRA 8, two alternative management procedure options for CRA 7 (an agreed and proposed revised procedure), and a proposed new management procedure for CRA 5. The options are:

Stock	Option	TAC	TACC	Customary Allowance	Recreational Allowance	Other mortality
CRA 4	**Option 1:** Increase the TAC based on the operation of the agreed CRA 4 management procedure	661.9 tonnes	466.9 tonnes	35 tonnes	85 tonnes	75 tonnes
	Option 2: Retain the current TAC, TACC and allowances	610.625 tonnes	415.625 tonnes	35 tonnes	85 tonnes	75 tonnes
CRA 5	**Option 1:** Accept the proposed new CRA 5 management procedure and then increase the TAC based on its operation	522.1 tonnes	350 tonnes	10 tonnes	110.1 tonnes	52 tonnes
	Option 2: Retain the current TAC, TACC and allowances	467 tonnes	350 tonnes	40 tonnes	40 tonnes	37 tonnes
CRA 7	**Option 1:** Accept the proposed revised CRA 7 management procedure and then maintain the TAC based on its operation	104.5 tonnes	84.5 tonnes	10 tonnes	5 tonnes	5 tonnes
	Option 2: Reduce the TAC based on the operation of the agreed CRA 7 management procedure	95.7 tonnes	75.7 tonnes	10 tonnes	5 tonnes	5 tonnes
	Option 3: Retain the current TAC, TACC and allowances	104.5 tonnes	84.5 tonnes	10 tonnes	5 tonnes	5 tonnes
CRA 8	**Option 1:** Reduce the TAC based on the operation of the agreed CRA 8 management procedure	1053 tonnes	962 tonnes	30 tonnes	33 tonnes	28 tonnes
	Option 2: Retain the current TAC, TACC and allowances	1110 tonnes	1019 tonnes	30 tonnes	33 tonnes	28 tonnes

64. The NRLMG considers that management procedures are an appropriate way of ensuring that the TAC is consistent with the statutory objective of managing the stock at or above *Bmsy.*

CRA 4 Options

65. The proposed variation to the CRA 4 TAC under Option 1 is the result of the operation of the CRA 4 management procedure that the Minister of Fisheries agreed to use in March 2009 to guide TAC setting for this stock until the 2011-12 fishing year (this is the procedures last year of operation before a scheduled review next year).

66. Implementing the procedure would result in a TAC increase of 51.275 tonnes. The NRLMG proposes allocating the full TAC increase to the commercial sector because they received a significant reduction in TACC (54% decrease) in 2009 while allowances to other sectors remained constant. Commercial representatives to the NRLMG also consider it reasonable for the commercial sector to receive the full TAC increase because the proposed 2011 TACC increase represents the increase that could have been taken in 2010 but was declined by the majority of industry participants. Although uncertain, best available information suggests existing CRA 4 customary Maori and recreational catch is within the allowances allocated for these interests.

67. The NRLMG advises retaining the current CRA 4 TAC (Option 2) is also an acceptable option because both options are expected to ensure a sustainable CRA 4 fishery.

CRA 5 Options

68. The proposed variation to the CRA 5 TAC under Option 1 is the result of the operation of the proposed new CRA 5 management procedure presented for consideration in Paper 1: "*Proposal to use new management procedures to guide TAC setting in CRA 5 and CRA 7*". The NRLMG has reviewed best available information and has identified no reason why the Minister should not use the results of the proposed CRA 5 management procedure to guide statutory TAC setting decisions.

69. If the Minister chooses to be guided by the CRA 5 management procedure it is proposed that the TAC will increase by 55.1 tonnes. The TAC increase is the result of changes to non-commercial allowances to reflect best available information on catch levels. Based on this information, the NRLMG is consulting on proposals to decrease the allowance for customary Maori from 40 tonnes to 10 tonnes, increase the allowance for recreational interests from 40 tonnes to 110.1 tonnes and increase the allowance for other sources of fishing-related mortality (eg, illegal fishing) from 37 tonnes to 52 tonnes. However, there is considerable uncertainty around the estimates of non-commercial catches and other mortality, in particular recreational removals.

70. The NRLMG notes the non-commercial allowance proposals do not include any recommendations to introduce new constraints on catch for any sector at this time (eg, amateur bag limit changes).

71. The NRLMG advises retaining the current CRA 5 TAC (Option 2) is also an acceptable option because both TAC options are expected to result in a sustainable CRA 5 fishery.

CRA 7 Options

72. The TAC options presented for CRA 7 are the result of the operation of current and proposed revised CRA 7 management procedures that are presented for consideration in Paper 1: "*Proposal to use new management procedures to guide TAC setting in CRA 5 and CRA 7*".

73. The NRLMG proposes that the Minister chooses to be guided by the revised CRA 7 management procedure when setting the CRA 7 TAC for the 2011-12 fishing year. The proposed revised CRA 7 management procedure is expected to provide more stability and there would be fewer

dramatic changes in the TAC than the current procedure. If the Minister chooses to use the new management procedure (Option 1), the TAC for CRA 7 would be retained for 2011-12. If the Minister chooses to be guided by the current CRA 7 management procedure (Option 2) it is proposed that the TAC will decrease by 8.8 tonnes. Under Option 3 the CRA 7 TAC would be retained for 2011-12.

CRA 8 Options

74. The proposed variation to the CRA 8 TAC under Option 1 is the result of the operation of the CRA 8 management procedure that the Minister agreed to use in March 2008 to guide TAC setting for this stock until the 2012-13 fishing year.

75. Implementing the procedure would result in a TAC decrease of 57 tonnes. The NRLMG proposes allocating the full TAC decrease to the commercial sector only because they received both increases and decreases in commercial catch since 1999 and best available information suggests existing CRA 8 customary Maori and recreational allowances are not being caught at this time. The NRLMG considers reducing only the TACC provides greatest certainty that stock size will increase because catch from the commercial sector can be more directly controlled.

76. The NRLMG advises retaining the current CRA 8 TAC (Option 2) is also an acceptable option because both TAC options are expected to result in a sustainable CRA 8 fishery.

REASON FOR REVIEWING ROCK LOBSTER TACS AND ALLOWANCES

77. Agreed management procedures are currently in place for CRA 3, CRA 4, CRA 7 and CRA 8 rock lobster fisheries. In 2010, a new CRA 5 management procedure and a revised CRA 7 management procedure were evaluated. The management procedures are designed to move the biomass to, or maintain the biomass, of each stock above reference levels (*Bmsy* and or *Bref* (proxy for *Bmsy*)) as required under section 13 of the Act with a high degree of probability. Operation of the relevant management procedures results in a TAC that moves the stock to a level at or above *Bmsy*, or that is not inconsistent with this objective.

78. Operation of the CRA 3 management procedure in 2010 resulted in no proposed change to the CRA 3 TAC for the 2011-12 fishing year. The CRA 3 fishery is therefore not discussed further in this paper.

79. The Minister may choose any alternative TAC based on his assessment of best available information. However, the NRLMG considers that there is considerable benefit in consistent implementation of TACs generated by agreed management procedures. Such an approach provides certainty to stakeholders over management actions, reduces conflict over management decision-making and meets legislative obligations.

TAC SETTING FOR ROCK LOBSTER STOCKS

80. When setting or varying a TAC for CRA 4, CRA 5, CRA 7 or CRA 8 rock lobster fisheries, the Minister is required to consider a range of matters from the Act (these are set out below).

International Obligations and Treaty of Waitangi (Section 5)

81. In setting or varying sustainability measures, the Minister must act in a manner consistent with New Zealand's international obligations to fishing and the provisions of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992.

82. The NRLMG considers that the proposed TAC options for rock lobster stocks are consistent with a wide range of international obligations that relate to fishing, including use and sustainability of fish stocks and maintaining biodiversity.

83. The NRLMG also considers that the proposed TAC options are consistent with the provisions of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992. The NRLMG notes that Maori have customary, commercial and recreational fishing interests. All proposals seek to maintain good fishing opportunities or improve stock health and, therefore, improve fishing opportunities for all sectors.

Purpose of the Act (Section 8)

84. The purpose of the Act is to provide for the utilisation of fisheries resources while ensuring sustainability, and defines the meanings of utilisation and sustainability. The TAC options presented in this paper for CRA 4, CRA 5, CRA 7 and CRA 8 provide for the utilisation of these stocks while ensuring sustainability.

Environmental Principles (Section 9)

85. When making any decision under the Act, the Minister must take into account the following environmental principles:

a) *Associated or dependent species should be maintained above a level that ensures their long-term viability*

Rock lobster is taken by potting and hand gathering fishing methods which have a relatively low level of by-catch. The levels of incidental catch landed from commercial rock lobster potting have been analysed for the period 1989 to 2003 (Bentley, Starr et al. 2005). Non-lobster catch landed ranged from 2 to 11% of the estimated rock lobster catch weight per quota management area (QMA) over this period. The most frequently reported incidental species caught (comprising on average greater than 99% of the bycatch per QMA) were, in decreasing order of catch across all stocks: octopus, conger eel, blue cod, trumpeter, sea perch, red cod, butterfish and leatherjackets. The TAC options proposed for CRA 5, CRA 7 and CRA 8 are unlikely to increase incidental bycatch from commercial rock lobster potting; the TAC increase proposed for CRA 4 may increase incidental bycatch slightly.

b) *Biological diversity of the aquatic environment should be maintained*

Potting is the main method of targeting rock lobster and is usually assumed to have very little direct impact on the aquatic environment. Several Australian studies have looked at the impacts of lobster pots on the environment. These studies suggest there is little impact on seaweed and other benthic communities, including fragile corals from rock lobster potting. Consequently, the TAC options proposed are unlikely to have a demonstrable adverse effect on biological diversity. In addition, all commercial fishing is prohibited within the internal waters of Fiordland (within the CRA 8 area) in an aim to protect important species and habitats in the area.

c) *Habitats of particular significance for fisheries management should be protected*

No habitats of particular significance to fisheries management have been identified that would be affected by the TAC options proposed.

Information Principles (Section 10)

86. The Minister must also take into account certain information principles when making decisions under the Act, including that decisions should be based on the best available information, that any uncertainty in the information available should be considered, and caution should be applied when information is uncertain, unreliable, or inadequate, but the absence of, or uncertainty in, information should not be used as a reason for postponing or failing to set a TAC. The TAC options presented in this paper are based on best available information and the NRLMG has endeavoured to set out the relevant uncertainty in, and inadequacy, of any information so that the appropriate caution can be applied in assessing the proposed management options.

Sustainability Measures (Section 11)

87. When setting or varying a sustainability measure such as a TAC, the Minister must take into account the following:

a) *Any effects of fishing on any stock and the aquatic environment*

The NRLMG considers the proposed TAC options for rock lobster stocks do not significantly affect any stock or the aquatic environment. Non-commercial methods (diving and potting) and the commercial potting method is assumed to have very little direct impact on non-target species and the aquatic environment.

b) *Any existing controls under the Act that apply to the stock or area concerned*

A range of management controls apply to rock lobster fisheries including minimum legal sizes, daily bag limits for amateur fishers, method restrictions, protection of egg-bearing females, closed areas and closed seasons (in CRA 7 only). No changes are proposed to these existing controls.

c) *The natural variability of the stock*

Recruitment to rock lobster stocks is highly variable. This variability was taken into account during development of management procedures for CRA 4, CRA 5, CRA 7 and CRA 8. This is done using Bayesian methods to deal with uncertain recruitment in constructing the operating model and by projecting uncertain recruitment forward when evaluating management procedures.

d) *Any conservation or fisheries services; and any decisions not to require these services*

The NRLMG is not aware of any conservation or fisheries services – or any decisions not to require conservation or fisheries services – that would be affected by the proposed TAC options.

e) *Any relevant fisheries plan approved under section 11A*

The NRLMG is not aware of any relevant fisheries plans approved under section 11A.

88. The Minister must also have regard to any provisions of the following that apply to the coastal marine area that he considers relevant:

a) *Any regional policy statement, regional plan, or proposed regional plan, or proposed regional plan under the Resource Management Act 1991*

There are seven regional councils (Hawkes Bay, Horizons, Greater Wellington, Environment Canterbury, Otago, Environment Southland, and West Coast) with jurisdictional boundaries covering CRA 4, CRA 5, CRA 7 and CRA 8. The NRLMG is not aware of any policy statements, regional plans or draft regional plans for these councils that are specifically relevant to TAC setting for rock lobster stocks.

b) *Any management strategy or management plan under the Conservation Act 1987*

There are seven Department of Conservation Conservancies (East Coast/Hawkes Bay, Wellington, Nelson/Marlborough, Canterbury, Otago, Southland, and West Coast) with jurisdictional boundaries covering CRA 4, CRA 5, CRA 7 and CRA 8. The NRLMG is not aware of anything in any management strategy or plan for these conservancies that are relevant to TAC setting for rock lobster stocks.

c) *Sections 7 and 8 of the Hauraki Gulf Marine Park Act 2000*

The CRA 4, CRA 5, CRA 7 or CRA 8 rock lobster fisheries do not intersect with the Hauraki Gulf Marine Park; therefore there are no relevant considerations.

Total Allowable Catch (Section 13)

89. TACs for rock lobster stocks are set under section 13 of the Act. Specifically, under section 13(2) the Minister must set a TAC that maintains, restores or moves the stock to a level that can produce the maximum sustainable yield (ie, *Bmsy*). However, before a TAC can be set under section 13(2) the Minister must be provided with an estimate of both current biomass and the biomass that can produce the maximum sustainable yield (ie, *Bmsy*).

90. Where current biomass or *Bmsy* estimates are not available or not reliable section 13 (2A) of the Act is used. Section 13 (2A) requires the Minister to set a TAC using the best available information, and that is not inconsistent with the objective of maintaining the stock at or above, or moving the stock towards or above, *Bmsy*.

91. In considering the way and rate in which a stock is moved towards or above a level that can produce the maximum sustainable yield (ie, *Bmsy*) under section 13(2)(b) or (c) or (2A), the Minister must have regard to such social, cultural and economic factors that he considers relevant.

92. *Bmsy* and proxy sustainability reference levels for CRA 4, CRA 5, CRA 7 and CRA 8 and social, cultural and economic factors are discussed in the context of each individual stock in later sections of this paper.

93. When setting a TAC under section 13 the Minister must have regard to the interdependence of stocks. Interdependence of stocks is where there is a direct trophic (ie, a stock is likely to be directly affected by the abundance of another stock) or symbiotic relationship between stocks.

94. Rock lobsters are predators of molluscs and other invertebrates. Survey and experimental work in north-eastern New Zealand has shown that predation by rock lobsters in marine reserves is capable of influencing the demography of surf clams of the genus *Dosinia*. Predation by rock lobsters has also been implicated in contributing to trophic cascades in a number of studies in New Zealand and overseas. For example, in Leigh marine reserve rock lobsters and snapper preyed on urchins, the densities of urchins decreased and kelp beds re-established in the absence of urchin grazing. This implies that rock lobster fishing is one of a number of factors that may alter the ecosystem from one more dominated by kelp beds to one more dominated by urchin barrens. Trophic cascades are hard to demonstrate however, as controlled experiments are difficult, food webs are complex and environmental factors are changeable.

95. Predation upon rock lobsters is known from octopus, blue cod, groper, southern dogfish, rig and seals; no evidence exists to suggest that the availability of rock lobster as prey determines the size of any of these populations.

96. Although uncertain, the TAC options proposed are unlikely to have any significant effect on the interdependence of stocks.

97. When setting a TAC under section 13 the Minister must also have regard to the biological characteristics of the stock and any environmental conditions affecting the stock. The TAC options proposed are based on the application of management procedures which have been tested using a model of the fishery that is based on a stock's assessment model. Stock assessment models take into account biological characteristics of the stock and variability in recruitment (which is thought to be related to environmental conditions).

SETTING OF NON-COMMERCIAL ALLOWANCES AND THE TACC

98. Sections 20 and 21 of the Act require the Minister to allow for Maori customary non-commercial fishing interests, recreational fishing interests and all other sources of fishing-related mortality within the TAC when setting or varying the TACC.

99. The Act does not provide an explicit statutory mechanism to apportion available catch between sector groups either in terms of a quantitative measure or prioritisation of allocation. Accordingly, the Minister has the discretion to make allowances for various sectors based on best available information.

100. When allowing for Maori customary interests the Minister must take into account any relevant mātaitai reserves and any area closure or fishing method restriction or prohibition made under section 186a of the Act. When allowing for recreational interests, the Minister must take into account any regulations made under section 311 of the Act that prohibit or restrict fishing in any area.

101. Allocation options and existing management controls, including mātaitai reserves and section 186a restrictions, are discussed individually for each rock lobster stock in subsequent sections.

REVIEW OF THE CRA 4 (WELLINGTON/HAWKES BAY) ROCK LOBSTER FISHERY

Summary of CRA 4 Management Options

102. The NRLMG is seeking comments on two management options for setting TACs and allowances for CRA 4:

Stock	Option	TAC	TACC	Customary Allowance	Recreational Allowance	Other mortality
CRA 4	**Option 1:** Increase the TAC based on the operation of the agreed CRA 4 management procedure	661.9 tonnes	466.9 tonnes	35 tonnes	85 tonnes	75 tonnes
	Option 2: Retain the current TAC, TACC and allowances	610.625 tonnes	415.625 tonnes	35 tonnes	85 tonnes	75 tonnes

103. Under **Option 1**, the TAC for CRA 4 would increase from 610.625 tonnes to 661.9 tonnes from 1 April 2011. Within this TAC it is proposed to increase the TACC from 415.625 tonnes to 466.9 tonnes as specified by the CRA 4 Management Procedure. It is proposed that the allowances set for customary Maori, recreational interests and other fishing mortality are not changed.

104. Under **Option 2**, the current CRA 4 TAC and allowances would be retained for the 2011-12 fishing year, beginning 1 April 2011.

Sustainability Indicators and Stock Status

105. A stock assessment was last performed for CRA 4 in 2005. No reliable estimate of *Bmsy* was calculated in this assessment. The MFish Plenary instead agreed to use a *Bmsy* proxy, *Bref*, which is the autumn-winter (April through September) vulnerable biomass associated with the period 1979-88. 1979-88 was a period when the CRA 4 stock showed good productivity and was demonstrably safe: it subsequently declined to lower levels then recovered.

106. *Bmin* for CRA 4 is defined as the lowest autumn-winter vulnerable biomass in the observed history of the CRA 4 fishery.

107. The 2005 CRA 4 stock assessment results indicated that stock size in 2004-05 was well above *Bmin* and *Bref*. The median expectation was that stock size would decline slightly over the subsequent three years but would remain above *Bref.* Uncertainty around these median projections was very high. In the event, the stock declined substantially as demonstrated by analysis of CPUE information.

108. Standardised CPUE is considered to be a reliable indicator of relative stock size in CRA 4 and is the abundance indicator used in the agreed CRA 4 Management Procedure. The history of commercial autumn-winter CPUE in CRA 4 is shown in Figure 1. CPUE increased strongly from 1993 to 1998, and then declined to 2007, increased strongly in 2009 but decreased by 3.4% in 2010.

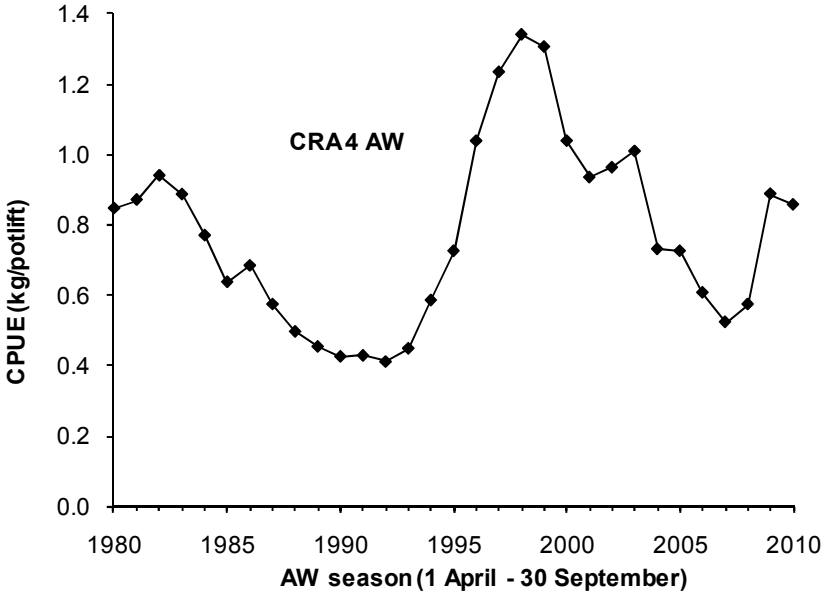


Figure 1: *The history of autumn-winter CPUE in CRA 4*

Analysis of Management Options for CRA 4

109. An analysis of the setting of the TAC, non-commercial allowances and the TACC for CRA 4 is set out below.

TAC Setting

110. As there are no reliable estimates of current biomass and *Bmsy*, the Minister must set a TAC for CRA 4 under section 13(2A) of the Act. Best available information suggests the current CRA 4 stock is above the agreed *Bmsy* proxy, *Bref*.

111. Two TAC options are proposed for CRA 4:

Option 1 – Increase the TAC to 661.9 tonnes

112. Under Option 1, the CRA 4 TAC would be set at 661.9 tonnes. The proposed increase in TAC is specified by the CRA 4 Management Procedure that the Minister agreed to use in March 2009 to guide TAC setting in the fishery until the 2011-12 fishing year (this is the procedures last year of operation before a scheduled review next year).

113. A graphic representation of the CRA 4 Management Procedure is provided in Figure 2 (for further technical details on the CRA 4 Management Procedure refer to Attachment 1). The graph shows the TAC in the next year as a function of commercial autumn-winter CPUE in the current year. It also shows the CPUE values (coloured shapes) that generated the TAC proposals for the 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12 fishing years. Although autumn-winter CPUE decreased in the last year (from 0.871 kg/potlift to 0.857 kg/potlift) the operation of the management procedure has resulted in a proposed 51.275 tonne increase. This is because the Minister chose to set a TAC/TACC that was approximately 50 tonnes lower in 2010-11 than the recommended increase that was specified by the management procedure.

114. It is the NRLMG's view that the proposed TAC variation guided by the operation of the CRA 4 Management Procedure is "not inconsistent" with the objective of maintaining the stock at or above, or moving the stock to a level at or above *Bmsy* (or the accepted proxy) in a way and rate considered appropriate for the stock. This is because ongoing application of the CRA 4

Management Procedure is expected to meet Harvest Strategy Standard (HSS) requirements and maintain the stock above the agreed proxy, *Bref*, with higher than 50% probability and above *Bmin* with greater than 90% probability; simulation testing indicates the CRA 4 Management Procedure would maintain the stock above *Bref* with 93% probability and above *Bmin* with 100% probability. The CRA 4 management procedure also ensures that the Minister sets a TAC that maintains the stock at or above the reference levels (*Bmsy* or *Bref*) in a way and rate considered appropriate for the stock. This is because the management procedure uses current fishery data and is responsive to changes in abundance.

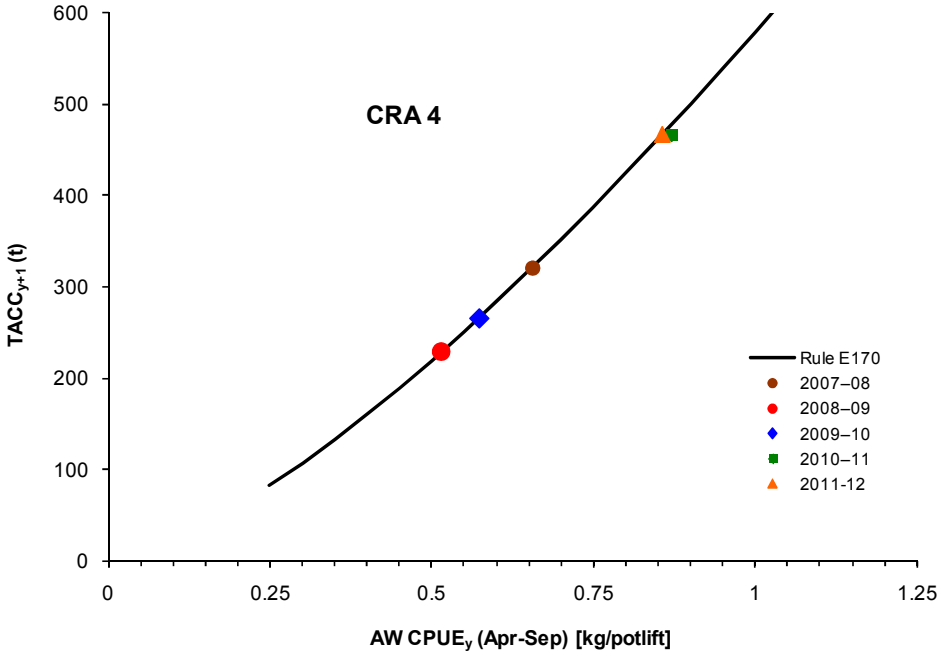


Figure 2: *Graphic representation of the CRA 4 Management Procedure.*

115. Option 1 is likely to increase the current utilisation benefit of the fishery. How the benefits are accrued will depend on allocation decisions. Historically, the TACC has been varied to give effect to variations to the TAC, meaning the commercial sector may benefit the most from the proposed TAC increase through the ability to take greater yield and potentially increase their revenue. Utilisation benefits for customary Maori and recreational interests are likely to be maintained under this option because best available information suggests the current CRA 4 stock size is above the agreed *Bmsy* proxy, *Bref* and ongoing application of the CRA 4 management procedure is designed to maintain stock size well above the reference level.

Option 2 – Retain the current TAC of 610.625 tonnes

116. Under Option 2, the current CRA 4 TAC of 610.625 tonnes would be retained for the 2011-12 fishing year. Retaining the current TAC for CRA 4 would likely result in a larger stock size than would occur under Option 1.

117. This option would constrain take of rock lobster in this fishery. However, retaining the current TAC would likely result in increased short-term abundance and therefore increased CPUE for commercial fishers, as well as increased catch rates in the non-commercial fisheries compared to Option 1. This could result in improved fishing opportunities for all sectors.

Setting of Non-commercial Allowances and the TACC

118. Proposals to change the CRA 4 non-commercial allowances and the TACC are discussed for Option 1 only because no TAC change is proposed under Option 2. The Minister may adopt different allowances and TACCs than those proposed.

Allowances for customary Maori, recreational interests and other mortality

119. Current allowances and estimated catches for customary Maori, recreational interests and other sources of fishing-related mortality (eg, illegal fishing) are outlined in Table 1 below for CRA 4.

CRA 4	Customary	Recreational	Other mortality
Current allowances	35 tonnes	85 tonnes	75 tonnes
Catch estimates (from 2005 CRA 4 stock assessment[1])	20 tonnes	47 tonnes	40 tonnes

Table 1: *Current CRA 4 allowances and estimated catches for non-commercial*

120. Under Option 1, where the TAC would be increased by 51.275 tonnes, the NRLMG proposes that no change is made to current allowances for customary Maori, recreational interests and other mortality. Although uncertain, best available information suggests existing CRA 4 customary Maori and recreational catch is within the allowances allocated for these interests.

121. When allowing for customary interests the Minister must take into account any relevant mātaitai reserve or closures/restrictions under section 186A. There is one mātaitai reserve located in CRA 4, the Moremore mātaitai reserve (Napier); and one Section 186A closure at Pukerua Bay (Wellington). The NRLMG considers the CRA 4 customary allowance adequately provides for the harvest of lobster likely to be taken from the mātaitai and section 186A closure within the QMA.

TACC

122. Commercial fishers are legally obliged to report how much rock lobsters they take on a monthly basis. Figure 3 shows historical CRA 4 landings and the TACC since the 1990-91 fishing year.

123. CRA 4 commercial stakeholders did not harvest the full TACC in 2004-05 (six tonne shortfall), in 2005-06 (72 tonne shortfall) or in 2006-07 (131 tonne shortfall). Using the CRA 4 Management Procedure to guide voluntary Annual Catch Entitlement (ACE) shelving (with the express purpose of halting declining abundance and to ensure the ongoing economic viability of the fishery), CRA 4 quota owners shelved 44% of their ACE in 2007-08 and 58% in 2008-09. The CRA 4 Management Procedure was formally accepted by the Minister in 2009 which when operated resulted in a significant reduction in TACC (54% decrease) for the 2009-10 fishing year, while allowances for other sectors remained constant.

124. The TAC/TACC was increased in 2010-11 but the increase was smaller than specified by the CRA 4 management procedure. A number of stakeholders, including the majority of industry participants, preferred a more modest increase in the TAC. The Minister decided to take a cautious approach given the fishery's recent history of catch limit reductions and "bank"

[1] Refer to the Mid-Year Stock Assessment Plenary report (Annex 3 of the 2010 NRLMG Annual Report).

approximately 50 tonnes of the increased abundance. The TACC was set at 415.625 tonnes and not 465.5 tonnes as first proposed.

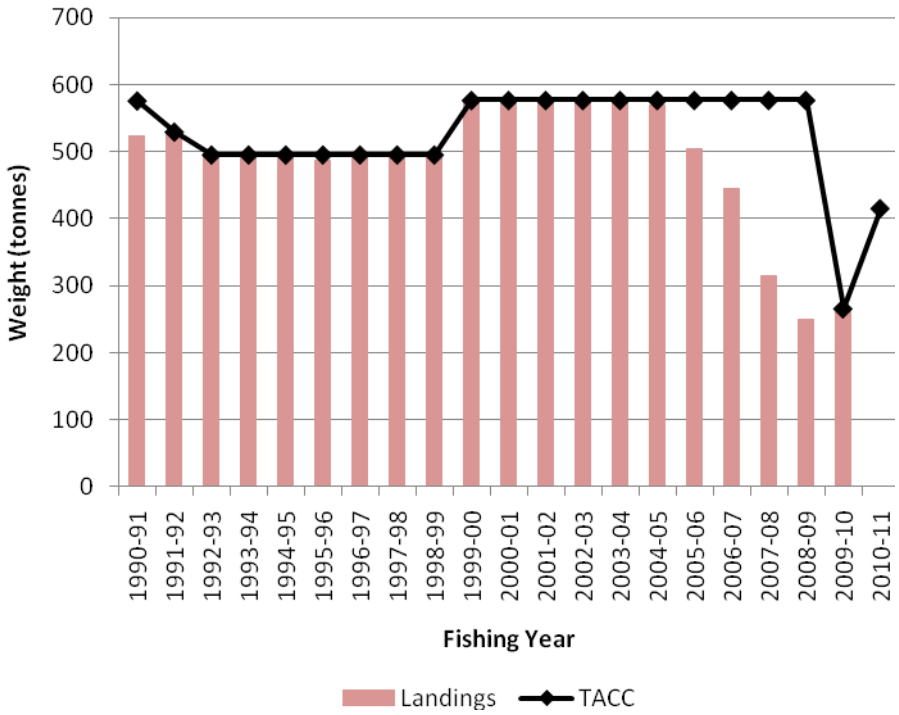


Figure 3: *CRA 4 historical landings (from monthly harvest return reports) and TACC. Note that landings are not available for 2010-11 because the year is incomplete.*

125. The NRLMG proposes allocating the full TAC increase to the commercial sector because in the past the commercial catch limit has been significantly reduced while allowances to other sectors remained constant. The NRLMG notes, however, that the Zone 5 Sports Fishing Council Clubs (Zone 5 encompasses the CRA 4 area) declared a voluntary bag limit reduction over several years (from 6 lobsters per person per day to 4) to support efforts to increase abundance in the fishery.

126. The NRLMG suggests that because the proposed TACC increase from 415.625 tonnes to 466.9 tonnes does not exceed the level in place before the 2009-10 reduction (the previous TACC was 577 tonnes), it is reasonable for the commercial sector to receive the full benefit of this TACC increase up to the point of the historical catch level. Commercial members to the NRLMG also consider it reasonable for the commercial sector to receive the full TAC increase because the proposed 51.275 tonne TACC increase for 2011 represents the increase that could have been taken in 2010 but was declined by the majority of industry participants. The NRLMG notes Zone 5 has now removed the voluntary bag limit reduction.

127. The NRLMG advises, based on average 2010 landing price information, that the proposed 51.275 tonne increase has the potential to generate approximately $2.84 million in additional earnings for the commercial sector based on current and predicted prices for CRA 4 landings.

CRA 4 Initial Position

128. Based on best available information and the analysis set out above, the NRLMG's preferred option is **Option 1**: increase the TAC for CRA 4 and allocate the increased catch only to the TACC as specified by the CRA 4 Management Procedure.

129. The NRLMG notes Option 2 (the status quo) is also an acceptable option. This is because both options will ensure a sustainable CRA 4 fishery. However, choosing not to follow a management procedure has possible consequences for the acceptability of management by management procedures.

REVIEW OF THE CRA 5 (CANTERBURY/MARLBOROUGH) ROCK LOBSTER FISHERY

Summary of CRA 5 Management Options

130. The NRLMG is seeking comments on two management options for settings TACs and allowances for CRA 5:

Stock	Option	TAC	TACC	Customary Allowance	Recreational Allowance	Other mortality
CRA 5	**Option 1:** Accept the proposed new CRA 5 management procedure and then increase the TAC based on its operation	522.1 tonnes	350 tonnes	10 tonnes	110.1 tonnes	52 tonnes
	Option 2: Retain the current TAC, TACC and allowances	467 tonnes	350 tonnes	40 tonnes	40 tonnes	37 tonnes

131. Under **Option 1**, the TAC for CRA 5 would increase from 467 tonnes to 522.1 tonnes from 1 April 2011. Within this TAC it is proposed to set allowances for customary Maori, recreational interests and other fishing mortality as noted above. It is proposed that the TACC would be retained at 350 tonnes.

132. The proposed variations result from the operation of the proposed CRA 5 Management Procedure (refer to Paper 1 titled – "*Proposal to use new management procedures to guide TAC setting in CRA 5 and CRA 7*"). The operation of this management procedure represents the best available information to guide TAC setting for CRA 5 fishery in the 2011-12 fishing year. The management procedure is designed to maintain the stock biomass above *Bref* and *Bmsy* with a high degree of probability.

133. Under **Option 2**, the current CRA 5 TAC and allowances would be retained for the 2011-12 fishing year, beginning 1 April 2011.

Sustainability Indicators and Stock Status

134. A stock assessment was performed for CRA 5 in 2010. In this assessment a reliable estimate of *Bmsy* was calculated along with the previously accepted *Bmsy* proxy, *Bref*, which is the autumn-winter vulnerable biomass associated with the period 1979-88. 1979-88 was a period when CRA 5 biomass was relatively stable and the stock showed good productivity. The two sustainability indicators *Bmsy* and *Bref* are consequently available for CRA 5.

135. *Bmin* for CRA 5 is defined as the lowest autumn-winter vulnerable biomass in the observed history of the CRA 5 fishery.

136. The 2010 CRA 5 stock assessment results indicate the current stock is well above *Bmin*, *Bref* and *Bmsy* by factors of 2 to 5. Biomass is predicted to decline over the next four years, at current levels of catch and recruitment, but will remain well above *Bmsy* and *Bref*.

137. Standardised CPUE is considered to be a reliable indicator of relative stock size in CRA 5 and is the abundance indicator used in the proposed CRA 5 Management Procedure. The history of commercial offset year (October through September) CPUE in CRA 5 is shown in Figure 4. CPUE

increased strongly from 1995-2004, decreased for two years, then increased in each of the past four years to its current historical high.

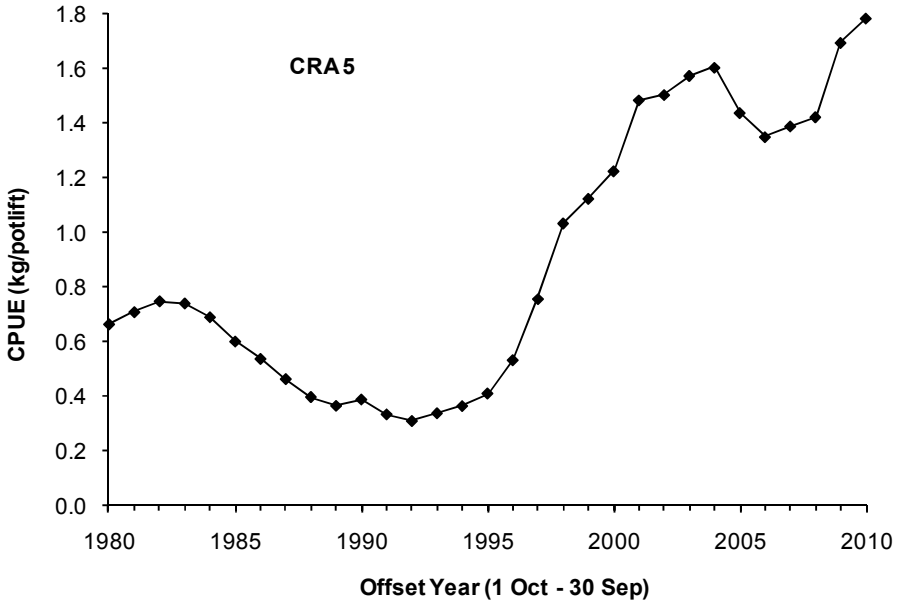


Figure 4: *The history of offset year CPUE in CRA 5*

Analysis of Management Options for CRA 5

138. An analysis of the setting of the TAC, non-commercial allowances and the TACC for CRA 5 is set out below.

TAC Setting

139. Best available information suggests the current CRA 5 stock is well above *Bmsy* (and the previously agreed proxy, *Bref*). As such the Minister is able to set a TAC that maintains the stock at or above this level (section 13(2)(a)).

140. Two TAC options are proposed for CRA 5:

Option 1 – Increase the TAC to 522.1 tonnes

141. Under Option 1, the CRA 5 TAC would be set at 522.1 tonnes. The proposed increase in TAC is specified by the proposed CRA 5 Management Procedure (refer Paper 1) and is the result of changes to non-commercial allowances to reflect new stock assessment model estimates of current catch levels; the proposal does not include any recommendations to introduce new constraints on catch for any sector at this time (eg, amateur bag limit changes).

142. The NRLMG considers that the proposed TAC variation, guided by the operation of the proposed CRA 5 Management Procedure, enables the stock to be maintained at a level at or above *Bmsy*. Ongoing application of the CRA 5 Management Procedure is also expected to meet HSS requirements and maintain the stock above *Bmsy*, (or the agreed proxy, *Bref)*, with greater than 50% probability and above *Bmin* with greater than 90% probability; simulation testing indicates the CRA 5 Management Procedure would maintain the stock above *Bmsy*, *Bref* and *Bmin* with greater than 95% probability.

143. Option 1 is likely to maintain the current utilisation benefit of the fishery. The change to the TAC is intended to reflect new stock assessment model estimates of current catch. The Rock

Lobster Fisheries Assessment Working Group (the Working Group) considers the model estimate to be the best estimate of recreational catch because it is likely that the level of recreational catch has increased as abundance; however, there is considerable uncertainty around non-commercial estimates.

144. Ongoing application of the proposed CRA 5 Management Procedure is expected to maintain the CRA 5 stock well above the reference levels; therefore good fishing opportunities for all sectors are likely to be provided for in the future.

Option 2 – Retain the current TAC of 467 tonnes

145. Under Option 2, the current CRA 5 TAC of 467 tonnes would be retained for the 2011-12 fishing year. Utilisation would not be restricted under this option because there are no proposals to include recommendations to introduce new constraints on catch for any sector at this time (eg, amateur bag limit changes).

146. The NRLMG notes that based on the Working Group's best estimates of non-commercial catch total removals from the fishery are likely to exceed the TAC of 467 tonnes; however, there is considerable uncertainty around non-commercial estimates.

Setting of Non-commercial Allowances and the TACC

147. Proposals to change CRA 5 non-commercial allowances and the TACC are discussed for Option 1 only because no change is proposed to the TAC under Option 2. The Minister may adopt different allowances and TACCs than those proposed.

Allowances for customary Maori, recreational interests and other mortality

148. Current allowances and estimated catches for customary Maori, recreational interests and other sources of fishing-related mortality (eg, illegal fishing) are outlined in Table 2 below for CRA 5.

CRA 5	**Customary**	**Recreational**	**Other mortality**
Current allowances	40 tonnes	40 tonnes	37 tonnes
Catch estimates (from 2010 CRA 5 stock assessment[2])	10 tonnes	110.1 tonnes	52 tonnes

Table 2: *Current CRA 5 allowances and estimated catches for non-commercial*

CRA 5 Allowance for Customary Maori

149. Under Option 1, it is proposed that the current allowance for customary Maori would decrease from 40 tonnes to 10 tonnes in CRA 5. The allowance represents the results of Working Group discussions on current customary harvest levels rather than a cap on the amount that can be harvested by customary fishers.

150. The Working Group agreed to use an estimate of 10 tonnes to represent customary catch for the 2010 CRA 5 stock assessment (a constant value of 10 tonnes is also used in the operation of the proposed CRA 5 Management Procedure). In determining an appropriate customary catch estimate for CRA 5, MFish provided available information on customary catches from two

[2] Refer to the Mid-Year Stock Assessment Plenary report (Annex 3 of the 2010 NRLMG Annual Report).

sources: the South Island Customary Regulations 1999 and Regulation 27A of the Fisheries (Amateur Fishing) Regulations 1986. When these data were summarised (using a mean weight of 0.499 kg/lobster) the estimated catch from customary sources was about 1 tonne in any fishing year, which is much smaller than the 10 tonne estimate used in the stock assessment. However, information on the quantity of lobster harvested under customary fishing permits or authorisations is currently incomplete; therefore 1 tonne is likely to be an underestimate of customary catch.

151. When allowing for customary interests the Minister must take into account any relevant mātaitai reserve or closures/restrictions under section 186A. There are four mātaitai reserves located in CRA 5 along the east coast of the South Island: the Wairewa/Lake Forsyth, Rapaki, Te Kaio and Koukourarata mātaitai reserves. The NRLMG notes the proposed CRA 5 customary allowance will adequately provide for the harvest of lobster likely to be taken from the mātaitai's within the QMA.

CRA 5 Allowance for Recreational Interests

152. Under Option 1, it is proposed that the current allowance for recreational interests would increase from 40 tonnes to 110.1 tonnes in CRA 5. The proposed allowance reflects the result of Working Group discussions on the relation between recreational catch and abundance, and is an output from the proposed management procedure based on observed CPUE.

153. In the 2010 CRA 5 stock assessment the Working Group estimated recreational catches after 1979 by scaling the 1994/96 recreational diary survey catch estimates to the spring-summer commercial CPUE from statistical area 917 (Kaikoura) only (rather than all of CRA 5 CPUE), as this is considered to be the area most representative of recreational effort. This procedure results in a recreational catch trajectory that shows a strong increasing trend since the mid-1990s and exceeds 100 tonnes since 2005. The proposed 110.1 tonne recreational allowance is generated from the harvest control rule in the proposed CRA 5 management procedure (which is based on an operating model that uses the scaling procedure described above for recreational catches).

154. Anecdotal reports also suggest recreational catch in CRA 5 has increased with increasing abundance of rock lobster in the fishery.

155. The NRLMG notes that information on recreational removals is highly uncertain. The current 40 tonne allowance is based on historical estimates of recreational catch and has not been altered since 1999. It is likely that the level of recreational catch is related to abundance; however, there is no quantitative information to accurately estimate this relationship. Although the NRLMG considers the results of the method used in the 2010 stock assessment to estimate recreational catch to represent best available information on current recreational take, the estimate has not being validated using actual catch data.

CRA 5 Allowance for Other Mortality

156. Under Option 1, it is proposed that the current allowance for other sources of fishing-related mortality (eg, illegal fishing) would increase from 37 tonnes to 52 tonnes. This is technical adjustment based on available information.

157. The Working Group agreed to use an estimate of 52 tonnes to represent other mortality for the 2010 CRA 5 stock assessment (a constant value of 52 tonnes is also used in the operation of the proposed CRA 5 Management Procedure). In determining an appropriate estimate for other mortality, the Working Group used available estimates for illegal catches from 1990, as provided by MFish compliance over a number of years. There is little confidence in the estimates of illegal

catch because the estimates cannot be verified, but anecdotal evidence from MFish indicates a possible upward trend in illegal extractions in the CRA 5 area.

TACC

158. Commercial fishers are legally obliged to report how much rock lobsters they take on a monthly basis. Figure 5 shows historical CRA 5 landings and the TACC since the 1990-91 fishing year. The CRA 5 TACC has been fully caught since 1993 and has been set at 350 tonnes since 1999.

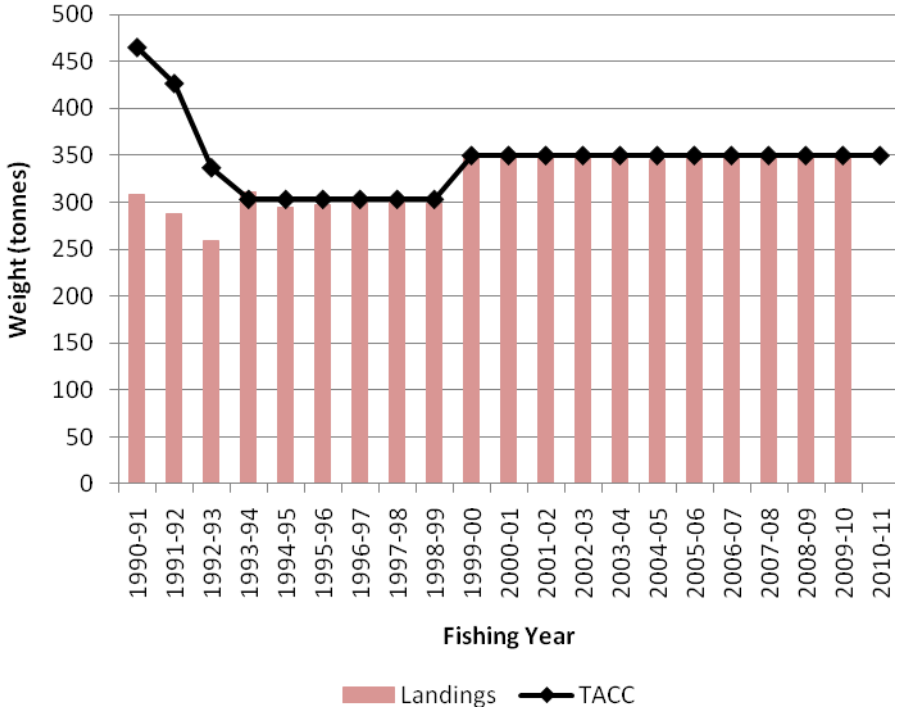


Figure 5: *CRA 5 historical landings (from monthly harvest return reports) and TACC. Note landings are not available for 2010-11 because the year is incomplete.*

159. A graphic representation of the proposed CRA 5 Management Procedure is provided in Figure 6 and shows the form of the TACC component only (for further technical details on the proposed CRA 5 Management Procedure refer to Appendix 2). The graph shows the TACC in the next year as a function of offset year CPUE in the current year.

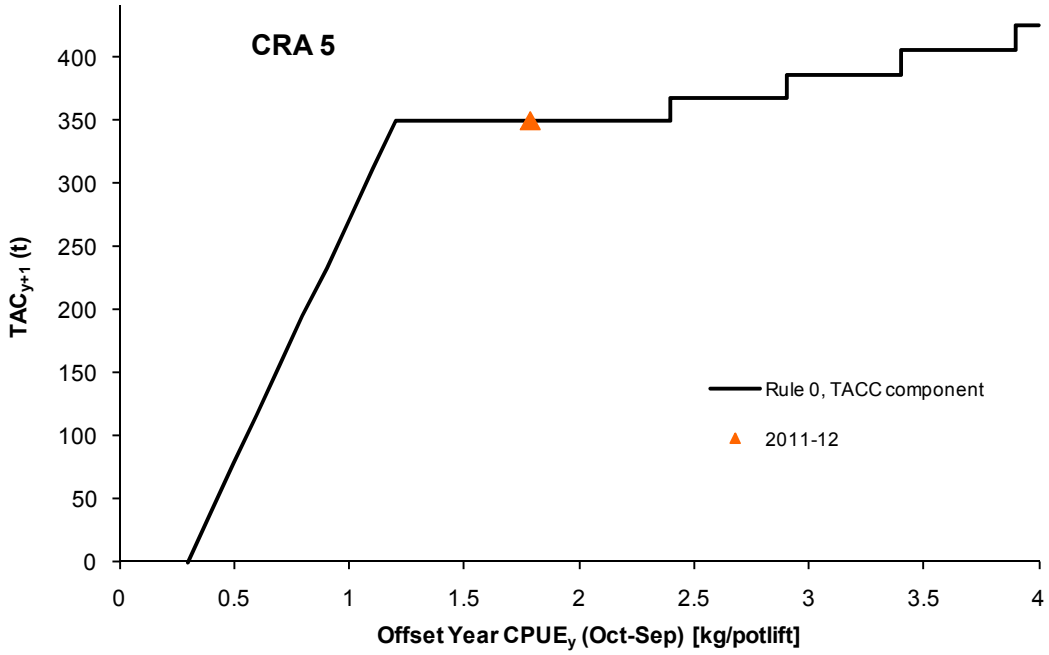


Figure 6: *Graphic representation of the CRA 5 Management Procedure. It shows the form of the TACC component only.*

160. The NRLMG proposes no change to the CRA 5 TACC for the next fishing year. This because the 2009-10 offset year CPUE for CRA 5 was 1.787 kg/potlift, giving a proposed TACC for the 2011-12 fishing year of 350 tonnes (this is shown by the orange triangle on the graph). In future years if CPUE increases above 2.4kg/potlift the management procedure will specify a TACC increase in steps (as shown in Figure 6 above).

CRA 5 Initial Position

161. Based on best available information and the analysis set out above, the NRLMG's preferred option is **Option 1**: increase the TAC for CRA 5 and alter the recreational and other mortality allowances as specified by the proposed CRA 5 Management Procedure. The NRLMG notes there was no agreement on how the customary allowance should be set.

REVIEW OF THE CRA 7 (OTAGO) ROCK LOBSTER FISHERY

Summary of CRA 7 Management Options

162. The NRLMG is seeking comments on three management options for setting TACs and allowances for CRA 7:

Stock	Option	TAC	TACC	Customary Allowance	Recreational Allowance	Other mortality
CRA 7	**Option 1:** Accept the proposed revised CRA 7 management procedure and then maintain the TAC based on its operation	104.5 tonnes	84.5 tonnes	10 tonnes	5 tonnes	5 tonnes
	Option 2: Reduce the TAC based on the operation of the agreed CRA 7 management procedure	95.7 tonnes	75.7 tonnes	10 tonnes	5 tonnes	5 tonnes
	Option 3: Retain the current TAC, TACC and allowances	104.5 tonnes	84.5 tonnes	10 tonnes	5 tonnes	5 tonnes

163. Under **Option 1**, the TAC for CRA 7 would be retained for the 2011-12 fishing year. This proposal results from the operation of the proposed revised CRA 7 Management Procedure (refer to Paper 1 titled – "*Proposal to use new management procedures to guide TAC setting in CRA 5 and CRA 7*"). The operation of the proposed new CRA 7 Management Procedure represents the best available information to guide TAC setting for the CRA 7 fishery in the 2011-12 fishing year.

164. Under **Option 2**, the TAC for CRA 7 would reduce from 104.5 tonnes to 95.7 tonnes from 1 April 2011, as specified by the current CRA 7 Management Procedure. Within this TAC it is proposed to decrease the TACC from 84.5 tonnes to 75.7 tonnes. It is proposed that the allowances set for customary Maori, recreational interests and other fishing mortality are not changed.

165. Under **Option 3**, the TAC for CRA 7 would be retained for the 2011-12 fishing year.

Sustainability Indicators and Stock Status

166. A stock assessment was last performed for CRA 7 in 2006. No reliable estimate of *Bmsy* was calculated in this assessment. The MFish Plenary instead agreed to use a *Bmsy* proxy, *Bref*, which is the pre-season autumn-winter vulnerable biomass associated with the period 1979-81. 1979-81 was a period when the CRA 7 stock showed good productivity and was demonstrably safe.

167. *Bmin* for CRA 7 is considered to be one half of *Bref*.

168. The 2006 stock assessment results indicated stock size in 2005-06 was well above *Bmin* and was approximately 1.7 times *Bref*.

169. In 2008, *Bmsy* was subsequently identified for CRA 7[3]. The 2008 analysis provides a method of estimating the average biomass at which yield was maximised (ie, *Bmsy*). On this basis *Bref* appears to be larger than *Bmsy* and is therefore a more conservative reference level.

170. Standardised commercial CPUE is considered to be a reliable indicator of relative stock size in CRA 7 and is the abundance indicator used in the CRA 7 Management Procedure (in both the agreed and proposed procedures). The history of offset year (October through September) CPUE in CRA 7 is shown in Figure 7. Except for one year, CPUE increased continuously and strongly between 1998 and 2008; it declined by 56% in 2009 and increased by 9% in 2010.

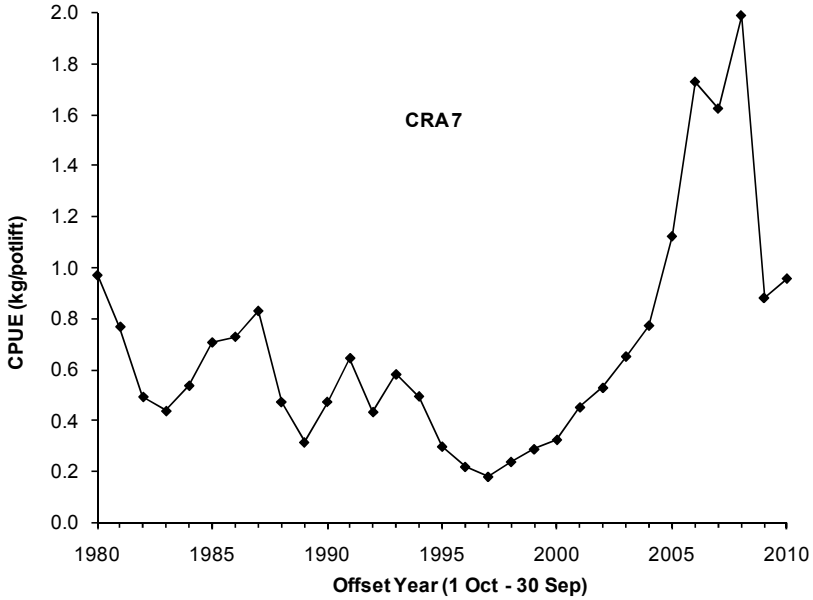


Figure 7: *The history of offset year CPUE in CRA 7*

Analysis of Management Options for CRA 7

171. An analysis of the setting of the TAC, non-commercial allowances and the TACC for CRA 7 is set out below.

TAC Setting

172. Best available information suggests the current CRA 7 stock is above *Bmsy* (and the agreed proxy, *Bref*). As such the Minister is able to set a TAC that maintains the stock at or above this level (section 13(2)(a)).

173. Three TAC options are proposed for CRA 7:

Option 1 – Retain the current TAC of 104.5 tonnes (as specified by the proposed revised CRA 7 management procedure)

174. Under Option 1, the current CRA 7 TAC of 104.5 tonnes would be retained for the 2011-12 fishing year. The proposed retention in TAC is specified by the proposed revised CRA 7 Management Procedure (refer Paper 1).

175. A graphic representation of the proposed revised CRA 7 Management Procedure is provided in Figure 8 (for further technical details on this procedure refer to Appendix 3). Operation of the

[3] Refer CRA 7 and CRA 8 Supplementary Advice for April 2008 Sustainability Measures: http://www.fish.govt.nz/en-nz/Consultations/Archive/2008/Rock+Lobster+7+and+8/default.htm

proposed management procedure initially suggests a TAC increase from 104.5 tonnes to 114.8 tonnes (based on the most recent offset year standardised CPUE of 0.957 kg/potlift). However, the rule does not allow an increase if the TAC was adjusted the previous year. Because the CRA 7 TAC was reduced from 209 tonnes to 104.5 tonnes for the 2010-11 fishing year, no change is proposed to the CRA 7 TAC for the 2011-12 fishing year.

176. The NRLMG considers the proposed TAC variation, guided by the operation of the revised CRA 7 Management Procedure, enables the stock to be maintained above *Bmsy*. This is because ongoing application of the CRA 7 Management Procedure is expected to meet HSS requirements and maintain the stock above the agreed proxy, *Bref*, with higher than 50% probability and above *Bmin* with greater than 90% probability; simulation testing indicates the revised CRA 7 Management Procedure would maintain the stock above *Bref* with 85% probability and above *Bmin* with 98% probability.

177. Overall the NRLMG considers the revised CRA 7 Management Procedure will result in improved biomass levels over the medium and long terms. The proposed procedure is expected to have a higher average CPUE compared with the current rule (Option 2), and, because of increased abundance, the procedure results in fewer years where stock biomass is predicted to be less than the agreed proxy, *Bref*.

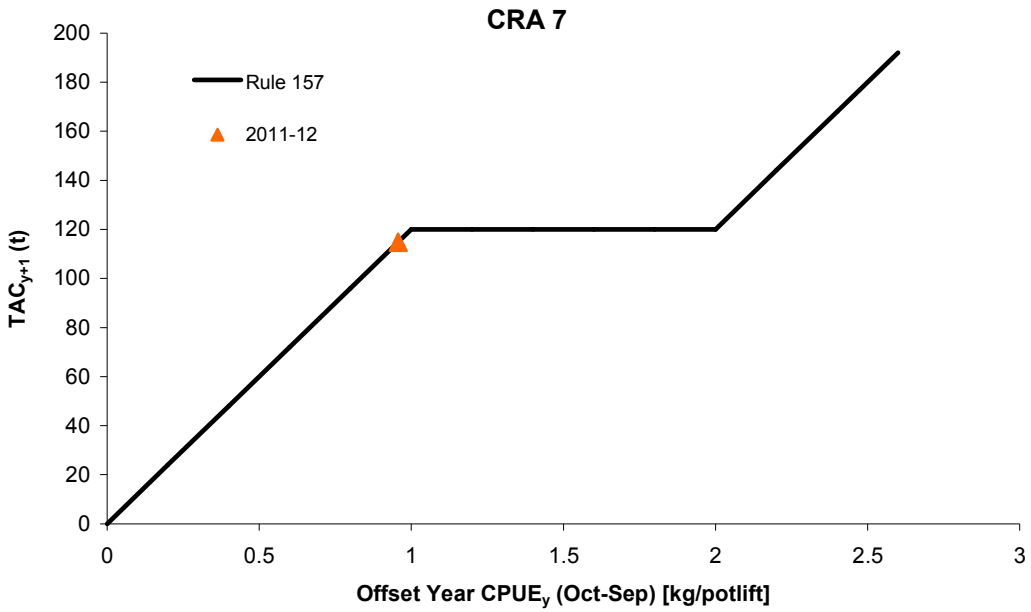


Figure 8: *Graphic representation of the proposed 2010 CRA 7 Management Procedure.*

178. Option 1 will maintain the current utilisation benefit of the fishery. The proposed revised CRA 7 Management Procedure would be expected to provide more stability in the TAC: there would be fewer dramatic changes in the TAC than under Option 2. Depending on allocation decisions, this option would likely benefit the commercial sector the most because it would enable them to stabilise (and potentially increase) their utilisation benefit. Utilisation benefits for customary Maori and recreational interests are likely to be improved or at least maintained under this option. This is because the ongoing application of the revised management procedure is expected to maintain the CRA 7 stock well above the reference level; therefore good fishing opportunities for all sectors are likely to be provided for in the future.

Option 2 – Reduce the TAC to 95.7 tonnes

179. Under Option 2, the CRA 7 TAC would be set at 95.7 tonnes. The proposed decrease in TAC is specified by the current CRA 7 Management Procedure that the Minister agreed to use in March 2008 to guide TAC setting in the fishery until the 2012-13 fishing year.

180. A graphic representation of the CRA 7 Management Procedure is provided in Figure 9 (for further technical details on the current CRA 7 Management Procedure refer to Appendix 3). The graph shows the TAC in the next year as a function of offset-year CPUE in the current year. It also shows the CPUE values (coloured shapes) that generated the TAC proposals for the 2008-09, 2009-10, 2010-11 and 2011-12 fishing years. Although offset year CPUE increased in the last year (from 0.803 kg/potlift to 0.957 kg/potlift) the operation of the current CRA 7 management procedure has resulted in a proposed 8.8 tonne reduction to the TAC. This is because for the previous fishing year (2010-11) the TAC decrease could have been larger, but it was limited by the 50% maximum change threshold of the management procedure.

181. The NRLMG considers the proposed TAC variation, guided by the operation of the current CRA 7 Management Procedure, enables the stock to be maintained above *Bmsy*. This is because ongoing application of the CRA 7 Management Procedure is expected to meet HSS requirements and maintain the stock above the agreed proxy, *Bref*, with higher than 50% probability and above *Bmin* with greater than 90% probability; simulation testing indicates the current CRA 7 Management Procedure would maintain the stock above *Bref* with 80% probability and above *Bmin* with 99% probability.

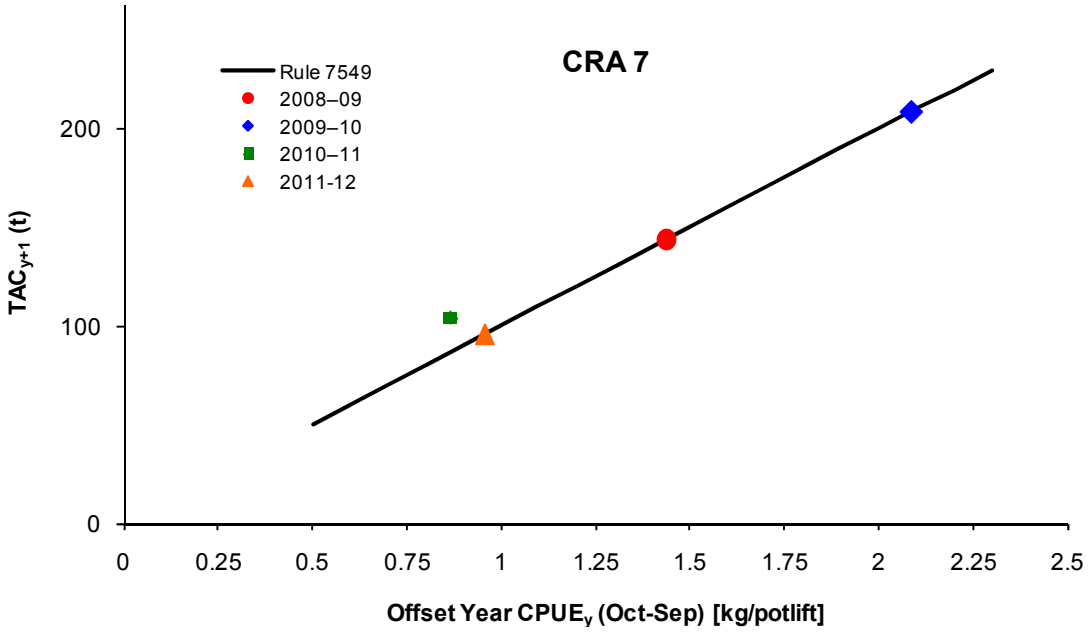


Figure 9: *Graphic representation of the "current" CRA 7 Management Procedure.*

182. Option 2 will reduce the current utilisation benefit of the fishery. Depending on allocation decisions, the commercial sector may be most affected by the proposed TAC decrease from the loss of opportunity costs.

183. Utilisation benefits for customary Maori and recreational interests are likely to be improved or at least maintained under this option. This is because the ongoing application of the current CRA 7 management procedure is expected to maintain the stock well above the reference level; therefore good fishing opportunities for all sectors are likely to be provided for in the future.

Option 3 – Retain the current TAC of 104.5 tonnes

184. Under Option 3, the current CRA 7 TAC of 104.5 tonnes would be retained for the 2011-12 fishing year. In comparison to Option 1, the proposed retention of the current CRA 7 TAC is not guided by any management procedure.

185. Option 3 will maintain the current utilisation benefit of the fishery; however the NRLMG considers this is a suitable option only if the management procedures described in Option 1 and 2 are not suitable.

Setting of Non-commercial Allowances and the TACC

186. Changes to CRA 7 non-commercial allowances and the TACC are discussed only for Option 2 because no TAC change is proposed under the alternative Options 1 and 3. The Minister may adopt different allowances and TACCs than those proposed.

Allowances for customary Maori, recreational interests and other mortality

187. Current allowances and estimated catches for customary Maori, recreational interests and other sources of fishing-related mortality (eg, illegal fishing) are outlined in Table 3 below for CRA7.

CRA 7	Customary	Recreational	Other mortality
Current allowances	10 tonnes	5 tonnes	5 tonnes
Catch estimates (from 2006 CRA 7 stock assessment[4])	1 tonne	4.51 tonnes	1 tonne

Table 3: *Current CRA 7 allowances and estimated catches for non-commercial*

188. Under Option 2, where the TAC would be reduced by 8.8 tonnes, the NRLMG proposes that no change is made to current allowances for customary Maori, recreational interests and other mortality. Although uncertain, best available information suggests existing CRA 7 customary Maori and recreational allowances are sufficient to cover recreational and customary catch.

189. When allowing for customary interests the Minister must take into account any relevant mātaitai reserve or closures/restrictions under section 186A. There are two mātaitai reserves located in CRA 7, the Puna wai-Toriki (Otago) and Moeraki mātaitai reserves. The NRLMG considers the CRA 7 customary allowance adequately provides for the harvest of lobster likely to be taken from the mātaitai within the QMA.

TACC

190. Commercial fishers are legally obliged to report how much rock lobsters they take on a monthly basis. Figure 10 shows historical CRA 7 landings and the TACC since the 1990-91 fishing year. From 1990 through to 2003, on average only 73% of the TACC was caught. The CRA 7 TACC has been fully caught from 2004 onwards except for 2009. The TACC has increased/decreased based on guidance from the operation of management procedures since 1996.

[4] Refer to the Mid-Year Stock Assessment Plenary report (Annex 3 of the 2010 NRLMG Annual Report).

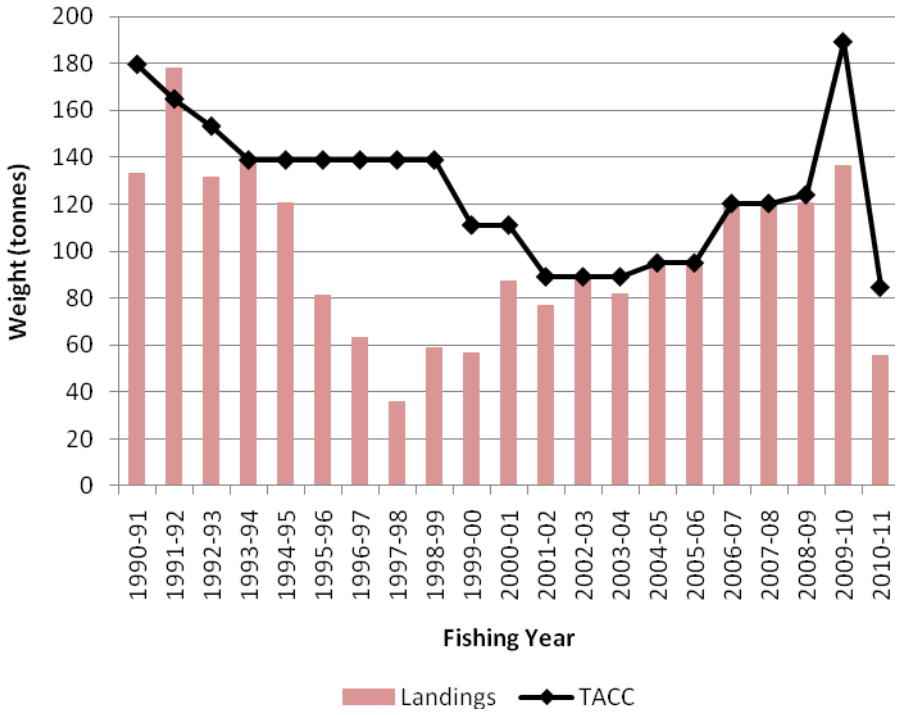


Figure 10: *CRA 7 historical landings (from monthly harvest return reports) and TACC. Note that landings may be incomplete for the CRA 7 2010-11 year which ended 19 November2010 (data extracted 5 December 2010)*

191. The NRLMG proposes reducing only the CRA 7 TACC under Option 2 because it considers there is greater certainty of benefit to the stock associated with a reduction to the TACC. This is because catch from the commercial sector can be more directly controlled and existing customary Maori and recreational allowances/catch estimates form a small component of the TAC. CRAMAC 7 has also agreed in the past to receive both increases and decreases in commercial catch (as shown in Figure 10 from 1999 onwards).

192. The NRLMG advises, based on average 2010 landing price information, that the proposed 8.8 tonne decrease in commercial catch of rock lobster has the potential to reduce the earnings for the commercial sector by approximately $487 thousand based on current and predicted prices for CRA 7 landings.

CRA 7 Initial Position

193. Based on best available information and the analysis set out above, the NRLMG's preferred option is **Option 1**: retain the TAC, TACC and allowances for CRA 7 based on the operation of the proposed revised CRA 7 management procedure.

194. The NRLMG has identified no reason why the Minister should not use the results of the proposed revised CRA 7 management procedure to guide statutory TAC setting decisions.

REVIEW OF THE CRA 8 (SOUTHERN) ROCK LOBSTER FISHERY

Summary of CRA 8 Management Options

195. The NRLMG is seeking comments on two management options for setting TACs and allowances for CRA 8:

Stock	Option	TAC	TACC	Customary Allowance	Recreational Allowance	Other mortality
CRA 8	**Option 1:** Reduce the TAC based on the operation of the agreed CRA 8 management procedure	1053 tonnes	962 tonnes	*No change*	*No change*	*No change*
	Option 2: Retain the current TAC, TACC and allowances	1110 tonnes	1019 tonnes	30 tonnes	33 tonnes	28 tonnes

196. Under **Option 1**, the TAC for CRA 8 would reduce from 1110 tonnes to 1053 tonnes from 1 April 2011, as specified by the CRA 8 Management Procedure. Within this TAC it is proposed to decrease the TACC from 1019 tonnes to 962 tonnes. It is proposed that the allowances set for customary Maori, recreational interests and other fishing mortality are not changed.

197. Under **Option 2**, the current CRA 8 TAC and allowances would be retained for the 2011-12 fishing year, beginning 1 April 2011.

Sustainability Indicators and Stock Status

198. A stock assessment was last performed for CRA 8 in 2006. No reliable estimate of *Bmsy* was calculated in this assessment. The MFish Plenary instead agreed to use a *Bmsy* proxy, *Bref*, which is the vulnerable stock size associated with the period 1979-80 to 1981-82. This was a period when the CRA 8 stock showed good productivity and was demonstrably safe: the stock subsequently declined to lower levels and then recovered.

199. *Bmin* for CRA 8 is considered to be one half of *Bref*.

200. The 2006 stock assessment results indicated that stock size in 2005-06 was well above *Bmin* and was approximately twice *Bref*.

201. In 2008, *Bmsy* was subsequently identified for CRA 8[5]. The 2008 analysis provides a method of estimating the average biomass at which yield was maximised (ie, *Bmsy*). On this basis *Bmsy* appeared to be slightly larger than *Bref* (at 1.14 times *Bref*) and *Bmsy* is therefore a more conservative reference level.

202. Standardised CPUE is considered to be a reliable indicator of relative stock size in CRA 8 and is the abundance indicator used in the agreed CRA 8 Management Procedure. The history of commercial offset year (October through September) CPUE in CRA 8 is shown in Figure 11. CPUE increased in every year between 1999 and 2009, sometimes strongly, but decreased by 16% in 2010.

[5] Refer CRA 7 and CRA 8 Supplementary Advice for April 2008 Sustainability Measures: http://www.fish.govt.nz/en-nz/Consultations/Archive/2008/Rock+Lobster+7+and+8/default.htm

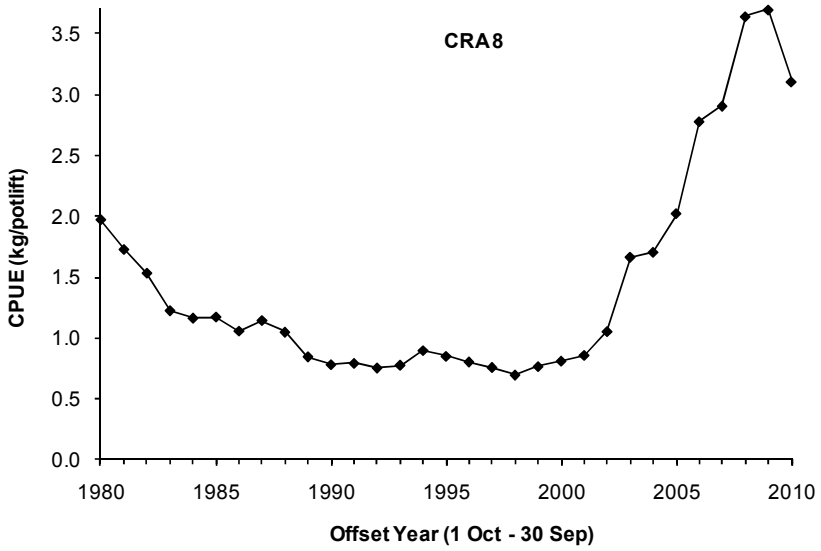


Figure 11: *The history of offset year CPUE in CRA 8*

Analysis of Management Options for CRA 8

203. An analysis of the setting of the TAC, non-commercial allowances and the TACC for CRA 8 is set out below.

TAC Setting

204. Best available information suggests the current CRA 7 stock is above *Bmsy* (and the agreed proxy, *Bref*). As such the Minister is able to set a TAC that maintains the stock at or above this level (section 13(2)(a)).

205. Two TAC options are proposed for CRA 8:

Option 1 – Reduce the TAC to 1053 tonnes

206. Under Option 1, the CRA 8 TAC would be set at 1053 tonnes. The proposed decrease in TAC is specified by the CRA 8 Management Procedure that the Minister agreed to use in March 2008 to guide TAC setting in the fishery until the 2012-13 fishing year. The NRLMG notes the proposed decrease in TAC is due to the conservative nature of the management procedure and is not due to sustainability concerns.

207. A graphic representation of the CRA 8 Management Procedure is provided in Figure 12 (for further technical details on the CRA 8 Management Procedure refer to Appendix 4). The graph shows the TAC in the next year as a function of offset-year CPUE in the current year. It also shows the CPUE values (coloured shapes) that generated the TAC proposals for the 2008-09, 2009-10, 2010-11 and 2011-12 fishing years. Offset year CPUE decreased in the last year (from 3.781 kg/potlift to 3.107 kg/potlift). This decrease, through the operation of the management procedure, has resulted in the proposed 57 tonne reduction to the TAC.

208. It is the NRLMG's view that the proposed TAC variation, guided by the operation of the CRA 8 Management Procedure, enables the stock to be maintained above *Bmsy*. This is because ongoing application of the CRA 8 Management Procedure is expected to meet HSS requirements and maintain the stock above the agreed proxy, *Bref*, with higher than 50% probability and above *Bmin* with greater than 90% probability; simulation testing indicates the CRA 8

Management Procedure would maintain the stock above *Bref* with 99% probability and above *Bmin* with 99% probability.

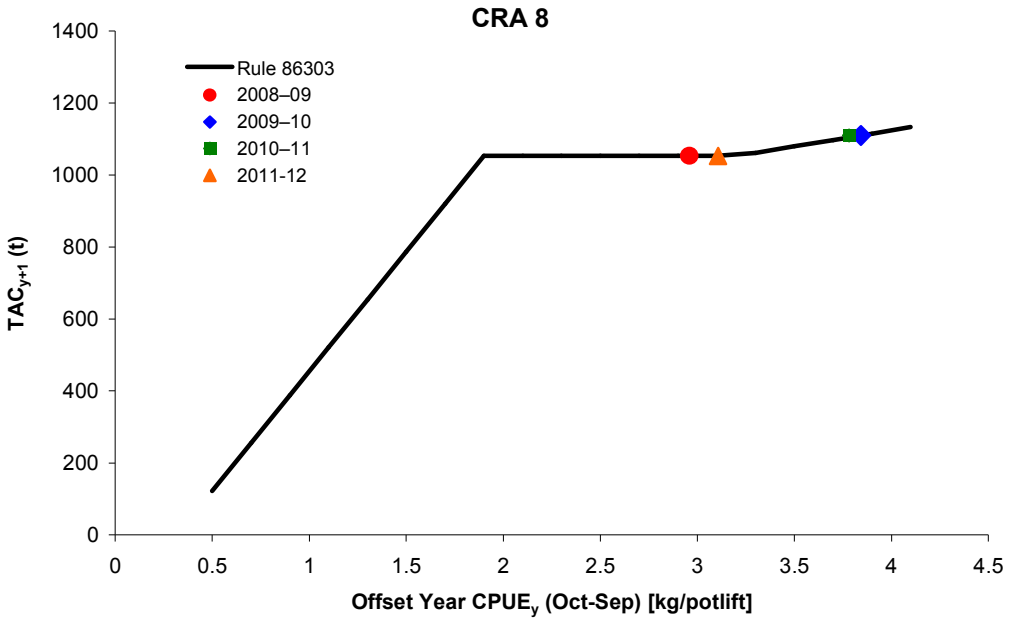


Figure 12: *Graphic representation of the CRA 8 Management Procedure.*

209. Option 1 will reduce the current utilisation benefit of the fishery. Depending on allocation decisions, the commercial sector may be most affected by the proposed TAC decrease from the loss of opportunity costs. Utilisation benefits for customary Maori and recreational interests are likely to be maintained under this option because the current CRA 8 stock size is well above the reference level and consequently there is a high availability of lobsters. However, because the ongoing application of the management procedure is expected to maintain the CRA 8 stock well above the reference level, good fishing opportunities for all sectors are likely to be provided for in the future.

Option 2 – Retain the current TAC of 1110 tonnes

210. Under Option 2, the current CRA 8 TAC of 1110 tonnes would be retained for the 2011-12 fishing year. The NRLMG advises that maintaining the current TAC could result in stock size declining further. A reduced stock size may also affect utilisation benefits by reducing fishing opportunities in the non-commercial and commercial fisheries.

211. Additionally, not responding to changes in CRA 8 stock size in a timely manner (as proposed under Option 1) could create uncertainty in future stock size, which could also affect utilisation benefits obtained from the fishery by all fishing sectors.

Setting of Non-commercial Allowances and the TACC

212. Changes to CRA 8 non-commercial allowances and the TACC are discussed only for Option 1 because no TAC change is proposed under the alternative Option 2. The Minister may adopt different allowances and TACCs than those proposed.

Allowances for customary Maori, recreational interests and other mortality

213. Current allowances and estimated catches for customary Maori, recreational interests and other sources of fishing-related mortality (eg, illegal fishing) are outlined in Table 4 below.

CRA 8	Customary	Recreational	Other mortality
Current allowances	30 tonnes	33 tonnes	28 tonnes
Catch estimates (from 2006 CRA 8 stock assessment[6])	2 tonnes	20.1 tonnes	18 tonnes

Table 4: *Current CRA 8 allowances and estimated catches for non-commercial*

214. Under Option 1, where the TAC would be reduced by 57 tonnes, the NRLMG proposes that no change be made to current allowances for customary Maori, recreational interests and other mortality. Although uncertain, best available information suggests existing CRA 8 customary Maori and recreational allowances are not being caught at this time.

215. When allowing for customary interests the Minister must take into account any relevant mätaitai reserve or closures and restrictions under section 186A. There are six mätaitai reserves located in CRA 8: the Tumu Toka (Waikawa Harbour), Oreti (Oreti Beach), Te Whaka Te Wera (Paterson Inlet, Stewart Island), Pikomamaku (Womens Island), Horomamae (Owen Island, Stewart Island), and Kaihuka (Kaihuka Island, Stewart Island) mätaitai reserves. The NRLMG considers the CRA 8 customary allowance adequately provides for the harvest of lobster likely to be taken from the mätaitai's within the QMA.

TACC

216. Commercial fishers are legally obliged to report how much rock lobsters they take on a monthly basis. Figure 13 shows historical CRA 8 landings and the TACC since the 1990-91 fishing year. The CRA 8 TACC has been fully caught since 1999, but has increased or decreased based on guidance from the operation of management procedures since 1996.

[6] Refer to the Mid-Year Stock Assessment Plenary report (Annex 3 of the 2010 NRLMG Annual Report).

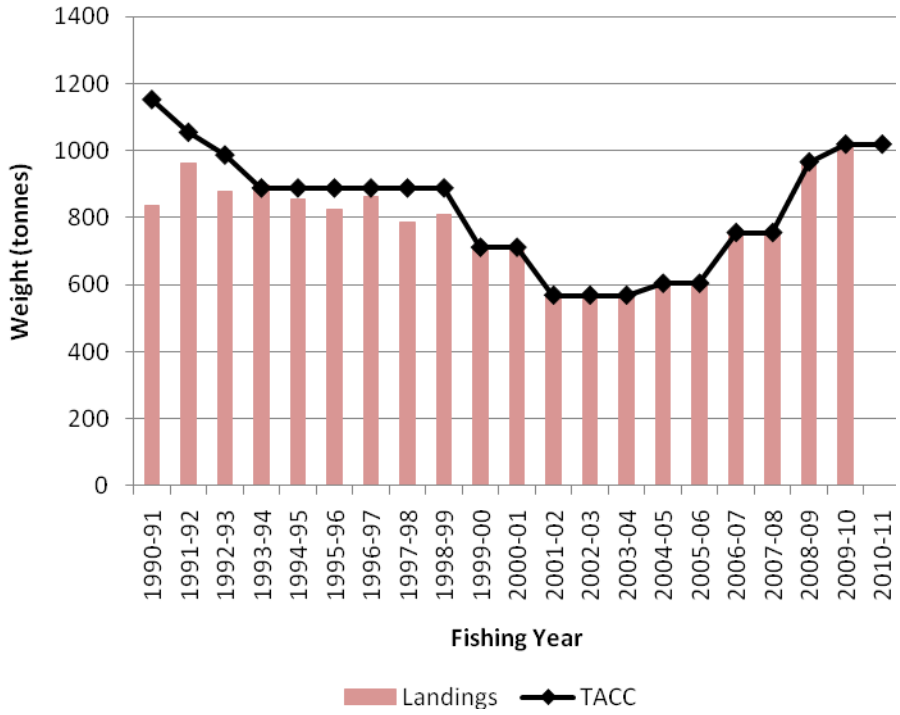


Figure 13: *CRA 8 historical landings (from monthly harvest return reports) and TACC. Note that landings are not available for 2010-11 because the year is incomplete.*

217. The NRLMG proposes to reduce only the CRA 8 TACC because it considers there is greater certainty of benefit to the stock associated with a reduction to the TACC. This is because catch from the commercial sector can be more directly controlled and existing customary Maori and recreational allowances/catch estimates form a small component of the TAC.

218. The CRA 8 rock lobster fisheries commercial stakeholder organisation (CRAMAC 8) has also agreed in the past to receive both increases and decreases in commercial catch (as shown in Figure 13 from 1999 onwards). Commercial members to the NRLMG note that CRAMAC 8 supports the proposed TACC variation as guided by the CRA 8 Management Procedure.

219. The NRLMG advises, based on average 2010 landing price information, that the proposed 57 tonne decrease in commercial catch of rock lobster has the potential to reduce the earnings for the commercial sector by approximately $3.16 million based on current and predicted prices for CRA 8 landings. The proposed TACC decrease also has the potential to affect export returns for processors and exporters of rock lobster which will compound the overall financial impact.

CRA 8 Initial Position

220. Based on best available information and the analysis set out above, the NRLMG's preferred option is **Option 1**: reduce the TAC for CRA 8 as specified by the CRA 8 Management Procedure by reducing only the TACC.

221. The NRLMG has identified no reason why the Minister should not use the results of the agreed CRA 8 Management Procedure to guide statutory TAC setting decisions.

4. REVIEW OF DEEMED VALUE RATES FOR SPINY AND PACKHORSE ROCK LOBSTER

SUMMARY

222. Table 1 summarises the NRLMG's proposals for deemed value rate changes for spiny and packhorse rock lobster stocks presented in this paper. These proposals were developed in accordance with the principles outlined in the Ministry of Fisheires 2007 Deemed Value Standard.

Option	Annual deemed value rate	Interim deemed value rate	Differential
Option 1: Maintain current rock lobster deemed values (status quo)	$100 per kg	$75 per kg	Standard
Option 2: Change the current rock lobster deemed values (NRLMG preferred option)	Increase to $110 per kg	Increase to $99 per kg (increased to 90% of annual rate)	Standard

Table 1: *Summary of proposed changes to deemed value rates for CRA 1 – 9 (inclusive) and PHC 1 rock lobster stocks*

INTRODUCTION

223. The purpose of the deemed value framework is to provide an incentive for fishers to acquire sufficient annual catch entitlement (ACE) to balance against catch, for stocks managed under the Quota Management System. The catch balancing regime is a key fisheries management tool, contributing to both sustainability and utilisation objectives. The sustainability objectives are achieved when deemed value rates encourage fishers to balance catch with available ACE and in so doing encourage harvesting to remain within the Total Allowable Commercial Catch (TACC). Incorrectly set deemed value rates have contributed to catches in excess of the TACC in some fisheries in the past, which may have sustainability implications.

224. Utilisation objectives are achieved by providing flexibility for commercial operators to manage unexpected and small overruns in ACE holdings by allowing periodic rather than continuous balancing. In the long term, the sustainability implications that may result from overfishing could result in TACC reductions, which also impact on utilisation objectives.

225. Interim deemed value rates are charged each month to individual fishers for every kilogram of fish landed in excess of ACE. If the fisher sourced enough ACE to cover his or her catch by the end of the fishing year, the interim deemed value rates paid are reimbursed. If the fisher did not source enough ACE, the difference between the interim and annual deemed value rates is charged for all catch in excess of ACE. Differential deemed value rates are charged at the end of the fishing year if the fisher harvested well in excess of his or her ACE holdings (e.g. more than 20% in excess of ACE).

ANALYSIS

Inclusion in the review of deemed value rates

226. The MFish 2007 Deemed Value Standard (the Standard) sets out criteria that indicate if a fish stock should be considered for a deemed value rates review. After applying these criteria, the Deemed Value Review Group[7] identified all spiny (CRA 1 – 9) and packhorse (PHC 1) rock lobster stocks for a review of their deemed value rates. The New Zealand Rock Lobster Industry Council (NZ RLIC) did not object to the MFish including the review of rock lobster deemed value rates in the NRLMG's review of sustainability measures and other management controls for rock lobster fisheries for the fishing year beginning 1 April 2011.

227. CRA 1 – 9 and PHC 1 have been included in this review because the landed and ACE prices have increased. This is a criterion that can trigger a review of deemed value rates under the Standard.

228. Other criteria for inclusion in the review are catch in excess of the TACC and catch in excess of an individual's ACE holdings while ACE remains unused. However, over the course of the last fishing year (2009-10), CRA 3 was the only stock for which reported catch exceeded the TACC (if only marginally, by 15 kg); reported catch for other rock lobster stocks was below their respective TACCs by a range of 72 kg (CRA 5) to 52,502 kg (CRA 7).

Annual deemed value rates

High value single species fisheries[8]

229. The Standard also specifies a set of principles to be applied when setting deemed value rates. One of these principles relates to high value single species fisheries, like rock lobster.

230. In these fisheries, the nature of the harvest activity means that any breach of the TACC is likely to be deliberate. Furthermore, rock lobster is a highly valuable species to both commercial and non-commercial fishers. Thus, it is necessary to provide a very strong incentive to catch only the amount for which fishers have ACE.

231. According to the Standard, this is accomplished by setting the annual deemed value rate at approximately twice the average landed price. A fisher would suffer a large loss on any catches in excess of ACE. By setting the deemed value rate at twice the landed price, it is unlikely that even if prices increase during a fishing year that any incentive would arise to land catch in excess of ACE.

232. The annual deemed value rates for CRA 1 – 9 and PHC 1 were considered by the Minister of Fisheries in October 2008 and were increased to the current $100 per kg to account for increases in the landed price at the time. This decision was consistent with the principle of setting annual deemed value rates at twice the average landed price.

233. NRLMG commercial members advise that average landed prices from 1 October 2009 to 30 September 2010 were $55.40 per kg for all CRA and PHC stocks and across all market grades. Similarly, MFish landed price surveys in the last year report landed prices for CRA stocks have increased from $38.53 to $56.61 and PHC 1 landed prices have increased from $27.12 to $48 between 2008-09 and 2010-11.

[7] The Deemed Value Review Group is made up of Ministry of Fisheries and Seafood Industry Council staff members.

[8] Although spiny red and packhorse rock lobster are two different species, they are treated as a single species fishery for the purpose of deemed value rate setting.

234. The proposed deemed value rates in this paper are based on an average landed price of $55 per kg. The NRLMG considers it important to continue the strategy of setting the annual deemed value rate at twice the landed price. It therefore proposes to increase the annual deemed value rates to $110 per kg.

Avoiding incentives to misreport

235. When two adjacent Quota Management Areas (QMAs) for the same species have substantially different deemed value rates, there may be an incentive to misreport origin and attribute the catch to the area where the lower deemed value rates prevail. This creates a risk when vessels fish across more than one QMA on one trip.

236. Following a request from the Seafood Industry Council in 2008, the recent approach when setting deemed value rates for rock lobster stocks has been to have the same deemed value rates across all CRA and PHC 1 stocks. This is because prices paid for rock lobster are on average the same across QMAs. As a consequence, setting the same deemed value rates across rock lobster QMAs eliminates any incentive to misreport catch to take advantage of lower deemed value rates in adjacent QMAs.

Interim deemed value rates

237. There is a risk that setting interim deemed value rates too low will delay the balancing of catch until the end of the fishing year. This may lead to a race for ACE and insufficient ACE to cover all catch at the end of the fishing year, potentially leading to the TACC being exceeded. Prior to the Standard, interim deemed value rates were generally set at 50% of the annual rate. The Standard states that the interim deemed value rates should remain at 50% of the annual rates for most stocks, recognising that higher interim deemed value rates for some stocks may be appropriate.

238. Following previous requests from commercial stakeholders, rock lobster interim deemed value rates are currently set at 75% of the annual deemed value rate to encourage fishers to balance their catch with ACE regularly instead of paying interim deemed value rates. However, given the desire to ensure commercial fishers secure sufficient ACE prior to commencing fishing, and in order to be consistent with the approach signalled in the MFish draft 2011 Deemed Value Standard[9], the NRLMG proposes that interim deemed value rates be increased to 90% of the annual rate.

Differential deemed value rates

239. Differential deemed value rates are used as an additional deterrent to not catch fish in excess of ACE by increasing the deemed value rate for an individual as more and more catch is taken in excess of the ACE held. Differential deemed value rates can also build in buffers that manage risk of future uncertainty in economic variables such as landed price, export price and foreign exchange rates.

240. The term 'standard differentials' refers to the most frequently used differential deemed value rate schedule. Those standard differentials increase the deemed value rate by 20% over the annual rate when catch equals more than 120% of ACE, by 40% when catch is more than 140% of ACE, by 60% when catch is more than 160% of ACE, by 80% when catch is more than 180% of ACE, and by 100% when catch is more than 200% of ACE. Prior to the Standard, standard differentials were the norm when differential deemed value rates were implemented.

[9] In the draft 2011 Deemed Value Standard, the Ministry of Fisheries proposes that interim deemed value rates be set at 90% of the annual deemed value rate. Except for the interim deemed value rate, the draft 2011 Standard is not used as the basis for this review of rock lobster deemed value rates.

241. The NRLMG proposes to continue setting standard differentials for rock lobster stocks. The differential deemed value rates for all CRA and PHC 1 stocks would be adjusted to match the approved annual deemed value rate, in accordance with the standard schedule.

NRLMG RECOMMENDATION

242. The NRLMG proposes to change the deemed value rates for all spiny and packhorse rock lobster stocks for the 2011-12 fishing year as follows:

a) increase the annual deemed value rate from $100.00 per kg to $110.00 per kg;

b) increase the interim deemed value rate from 75% to 90% of the proposed annual deemed value rate, thus from $75.00 per kg to $99.00 per kg; and

c) adjust the differential deemed value rates as outlined in Table 2 below:

Current differential rates		**Proposed differential rates**	
Catch in excess of ACE holdings	**Current deemed value rate**	**Catch in excess of ACE holdings**	**Proposed deemed value rate**
0-20 %	$ 100.00 per kg	**0-20 %**	$ 110.00 per kg
> 20 %	$ 120.00 per kg	**> 20 %**	$ 132.00 per kg
> 40 %	$ 140.00 per kg	**> 40 %**	$ 154.00 per kg
> 60 %	$ 160.00 per kg	**> 60 %**	$ 176.00 per kg
> 80 %	$ 180.00 per kg	**> 80 %**	$ 198.00 per kg
> 100 %	$ 200.00 per kg	**> 100 %**	$ 220.00 per kg

Table 2: *Proposed differential deemed value rates for CRA 1 – 9 and PHC 1 rock lobster stocks*

ATTACHMENT 1: SPECIFICATIONS OF THE CRA 4 MANAGEMENT PROCEDURE

This CRA 4 Management Procedure (rule E170) is based on the work of (Breen & Kim 2006b) and is specified as follows:

a)

$$TACC_{y+1} = 500\left(\frac{I_y}{0.9}\right)^{1.4}$$

where $TACC_{y+1}$ is the TACC (in tonnes) in year y+1 and I_y is standardised CPUE from the most recent autumn-winter season. The rule is shown in *Figure A*.

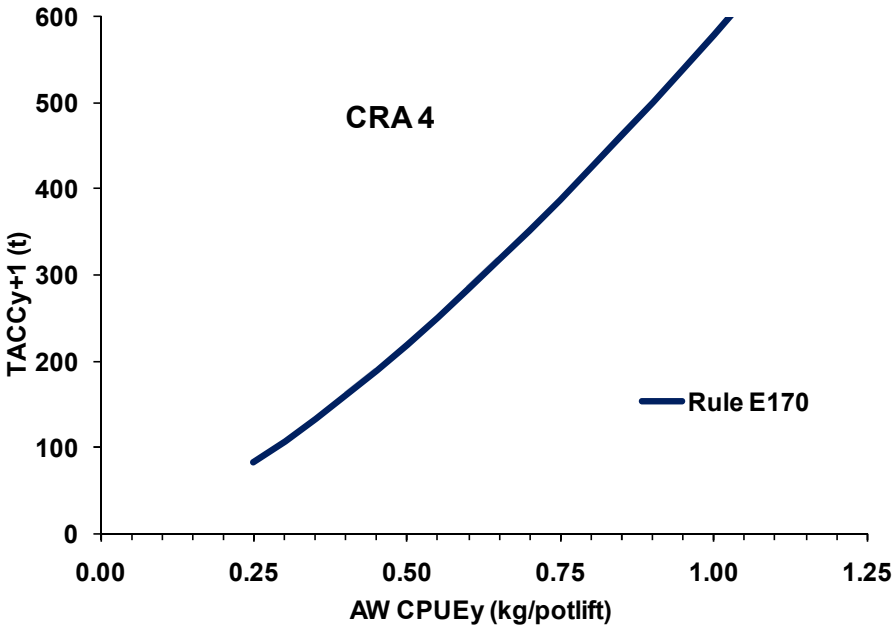


***Figure A*:** The CRA 4 management procedure, showing TAC in year y+1 as a function of AW CPUE in year y.

b) The output variable is TACC (tonnes) and that standardised CPUE (kg/pot) is to be used as the input variable;

c) The management procedure is to be evaluated every year (there is no "latent year"[10]);

d) If the procedure results in a TAC that changes by less than 5%, no change will be made; and

e) If the procedure results in a TAC that changes by more than 75%, the TAC will be changed by 75%.

[10] The original MPEs described by Breen & Kim (2006b) used an asymmetric latent year, in which a decrease could be made, but not an increase, in a year following a change. The latent year was dropped before a rule was adopted, at the request of NZ RLIC Ltd., after examination of the performance of the rule without a latent year.

The history of the CRA 4 Management Procedure is shown in *Table A* below.

Year	Applied to fishing year	AW CPUE (kg/potlift)	Rule result: TACC (tonnes)	Operational limit (tonnes)	TACC (tonnes)
2006	2007-08	0.656	321.1	339	577
2007	2008-09	0.515	228.9	240	577
2008	2009-10	0.573	265.9	266	266
2009	2010-11	0.871	465.5		415.6
2010	2011-12 (proposed)	0.857	466.9	*To be determined*	*To be determined*

Table A: History of the CRA 4 Management Procedure, showing proposed limits to the commercial fishery. The "operational limit" shows the level of voluntary shelving achieved for the 2007-08 and 2008-09 fishing years. "Rule result" is the result of the management procedure after operation of all its components including thresholds.

In late 2006, the rule delivered a specified catch limit of 321 tonnes. Not all quota owners shelved the requisite ACE, resulting in an operational limit of 339 tonnes, a 41% reduction from the TACC.

In late 2007, the rule delivered a specified catch limit of 228.9 tonnes. Not all quota owners shelved the requisite ACE, resulting in an operational limit of 245 tonnes, a 57% reduction from the TACC.

In late 2008, the rule delivered a specified catch limit of 265.9 tonnes. The Minister formally accepted the rule to guide statutory TAC setting in CRA 4 from the 2009-10 fishing year. This resulted in an operational limit of 266 tonnes, a 55 % reduction from the TACC.

In late 2009, the rule delivered a specified catch limit of 477.59 tonnes. This would represent an increase of 79.5%. However, the maximum change allowed under the rule is +/- 75%, thus the proposed TACC for 2010-11 was 465.5 tonnes. A number of stakeholders, including industry participants, were against an increase of this size. The majority of CRA 4 industry participants were in favour of banking some of the recommended increase to buffer against future recruitment variability. The Minister set the TACC at 415 tonnes and not 465.5 tonnes as first proposed.

In late 2010, the rule delivered a specified catch limit of 446.9 tonnes, a 12% increase in the TACC.

The NRLMG recommends that a review of the current and proposed CRA 4 management procedure should take place in 2011. This is because management procedures should not remain in place for longer than about five years without a review, because in five years the operating model used to evaluate management procedures will be obsolete and fishery performance should be re-evaluated.

ATTACHMENT 2: SPECIFICATIONS OF THE CRA 5 MANAGEMENT PROCEDURE

A proposed new management procedure was developed for CRA 5 in 2010. The proposed management procedure was based on a 2010 stock assessment and incorporates elements of the voluntary ACE-shelving rule that the CRA 5 industry has used since 2009.

The proposed CRA 5 management procedure specifies that:

a) The output variable is TAC (tonnes) and that standardised CPUE (kg/pot) is to be used as the input variable;

b) Standardised CPUE is to be based on the offset year from 1 October;

c) CPUE is to be standardised according to the recent usage described in annual Fishery Assessment Reports (FARs), using a data extract obtained in November to ensure that sufficient data from the most recent AW season have been entered;

d) The proposed new management procedure delivers a TAC result that consists of three separate components: a component for TACC, a component for recreational catch and a component for non-size-limited catches (customary and illegal).

e) The TACC component is based on the offset-year CPUE in the preceding year. The form of the TACC component, as a function of this CPUE, is shown in *Figure B*. Below a CPUE of 0.3 kg/potlift, the TACC is zero; between a CPUE of 0.3 and 1.2 kg/potlift, TACC increases linearly with CPUE to a plateau of 350 t, which extends to a CPUE of 2.4 kg/potlift. As CPUE increases above 2.4 kg/potlift, TACC increases in steps; which have a width of 0.5 kg/potlift and a height of 5% of the preceding TACC.

d) The TACC component of the proposed rule is specified as follows:

$$
\begin{aligned}
TACC_{y+1} &= 0 && \text{for } I_y \le 0.3 \\
TACC_{y+1} &= 388.89\left(I_y - 0.3\right) && \text{for } 0.3 < I_y \le 1.2 \\
TACC_{y+1} &= 350 && \text{for } 1.2 < I_y \le 2.4 \\
TACC_{y+1} &= 350\left(1.05^{\text{int}\left(\left(I_y - 2.4\right)/0.5\right)+1}\right) && \text{for } I_y > 2.4
\end{aligned}
$$

where $TACC_{y+1}$ is the TACC (in tonnes) in year *y*+1 and I_y is offset-year CPUE (in kg/potlift) in year *y*. The TACC component of the rule has no latent year and no thresholds for minimum and maximum change.

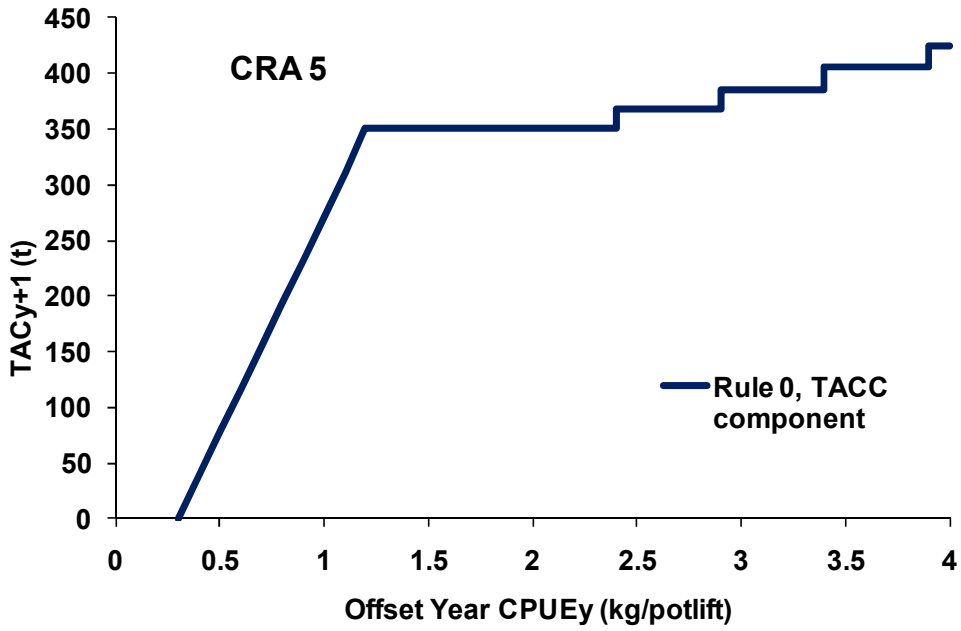


Figure B: The proposed TACC harvest control rule, a component of the proposed CRA 5 management procedure, showing TAC in year y+1 as a function of offset year CPUE in year y.

f) The recreational catch component of the proposed new management procedure is a multiplier on the previous year offset-year CPUE, reflecting a belief that recreational catch changes linearly in response to changes in abundance and that abundance is reflected in CPUE. These beliefs were incorporated into both the stock assessment and the management procedure evaluations. The recreational component of the proposed rule, $C_{y+1}^{recreational}$ in tonnes, is specified as follows:

$$C_{y+1}^{recreational} = 61.6 I_y$$

The other component of the proposed rule in tonnes is:

$$C_{y+1}^{customary+illegal} = 62$$

g) The management procedure is to be evaluated every year (no "latent year");

h) There is no limit to the amount by which a TAC may change.

ATTACHMENT 3: SPECIFICATIONS OF THE CRA 7 MANAGEMENT PROCEDURES

The current and proposed CRA 7 management procedure specifies that:

a) The output variable is TAC (tonnes) and that standardised CPUE (kg/pot) is to be used as the input variable,

b) Standardised CPUE is to be based on the offset year from 1 October;

c) CPUE is to be standardised according to the recent usage described in annual Fishery Assessment Reports (FARs), using a data extract obtained in November to ensure that sufficient data from the most recent AW season have been entered.

The Current CRA 7 Management Procedure

The current management procedure for CRA 7 (rule 7549) was accepted by the Minister for the 2008-09 fishing year.

In addition to the specifications listed above for both procedures, the current CRA 7 management procedure also specifies that:

a) The TAC is to be set at 100 times the standardised CPUE (*Figure C*);

b) The management procedure is to be evaluated every year (no "latent year");

c) If the procedure results in a TAC that changes by less than 5%, no change will be made; and

d) If the procedure results in a TAC that changes by more than 50%, the TAC will be changed by 50%.

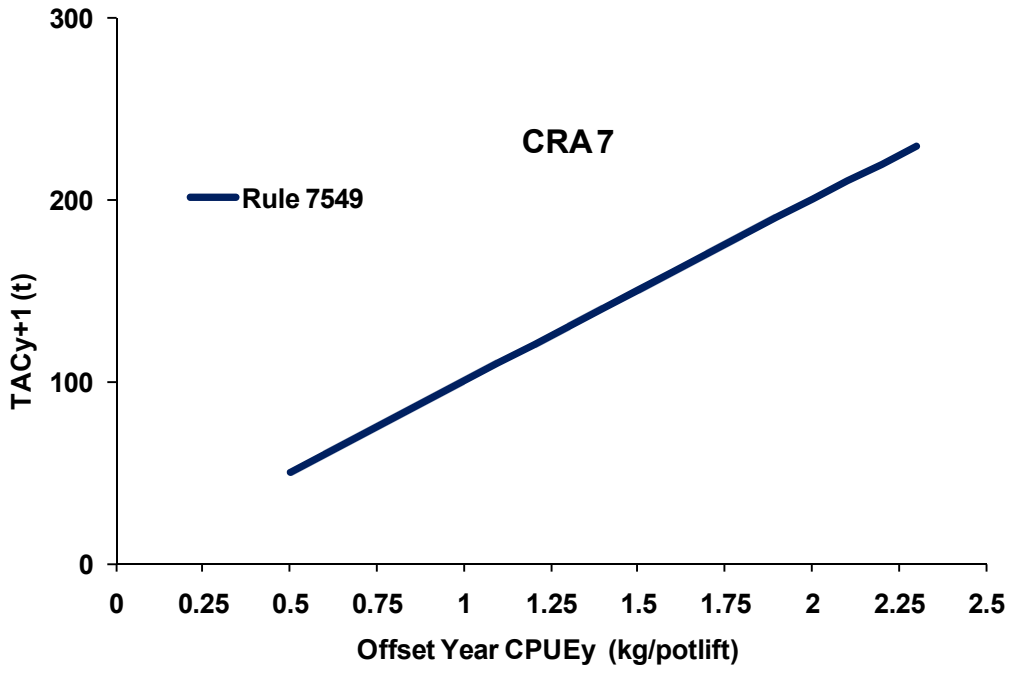


Figure C: The CRA 7 management procedure, showing TAC in year y+1 as a function of offset year CPUE in year y.

The history of the current CRA 7 Management Procedure is shown in *Table C* below.

Year	Applied to fishing year	AW CPUE (kg/potlift)	Rule result: TACC (tonnes)	TACC (tonnes)	TAC (tonnes)
2007	2008-09	1.439	143.9	123.9	143.9
2008	2009-10	2.090	209.0	189.0	209.0
2009	2010-11	0.803	104.5	84.5	104.5
2010	2011-12	0.957	95.7	*To be determined*	*To be determined*

Table C: History of the current CRA 7 Management Procedure, showing proposed limits to the commercial fishery. The "Rule result" is the result of the management procedure after operation of all its components including minimum and maximum change thresholds.

The Proposed CRA 7 Management Procedure

In 2010, the CRA 7 rock lobster fisheries commercial stakeholder organisation requested exploration of a revised management procedure to replace the apparent volatility of the CRA 7 TACC.

The proposed management procedure is shown in *Figure D*. It has a plateau of 120 t TAC between CPUE values of 1.0 and 2.0 kg/potlift, and increases linearly with increasing CPUE at the same slope above and below these values. It is expected that the TACC will be determined by subtracting the non-commercial allowances, which are currently 20 t.

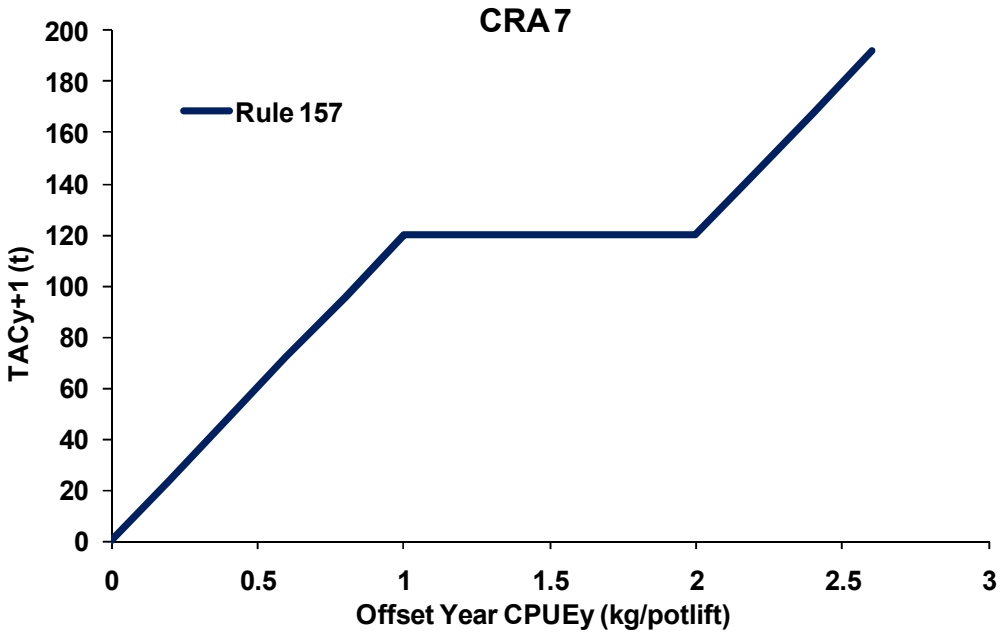


Figure D: The proposed new CRA 7 management procedure, showing TAC in year *y*+1 as a function of offset year CPUE in year *y*.

The rule is specified by:

a)

$$TAC'_{y+1} = 120 I_y \qquad \text{for } I_y < 1.0$$
$$TAC'_{y+1} = 120 \qquad \text{for } 1.0 \le I_y < 2.0$$
$$TAC'_{y+1} = 120\left(1 + \left(I_y - 2.0\right)\right) \qquad \text{for } I_y \ge 2.0$$

where TAC'_{y+1} is the rule's specified TAC for the next fishing year, before the operation of minimum and maximum change thresholds, and I_y is standardised CPUE from the most recent offset year.

b) The TAC can decrease in any year, but cannot increase if a change (either an increase or a decrease) was made to the TAC in the previous year (asymmetric latent year).

c) If the TAC change would be less than 10%, no change is made.

d) If the TAC change would be greater than 50%, the TAC is changed by 50% only.

The NRLMG recommends that a review of the current and proposed CRA 7 management procedures should take place in 2012. This is because management procedures should not remain in place for longer than about five years without a review, because in five years the operating model used to evaluate management procedures will be obsolete and fishery performance should be re-evaluated.

ATTACHMENT 4: SPECIFICATIONS OF THE CRA 8 MANAGEMENT PROCEDURE

The current management procedure for CRA 8 (rule 86303) was accepted by the Minister in 2008, and he used it to set catch limits for the 2008-09 fishing year.

The CRA 8 management procedure specifies that:

a) The output variable is TAC (tonnes) and that standardised CPUE (kg/pot) is to be used as the input variable;

b) Standardised CPUE is to be based on the offset year from 1 October;

c) CPUE is to be standardised according to the recent usage described in annual Fishery Assessment Reports (FARs), using a data extract obtained in November to ensure that sufficient data from the most recent AW season have been entered;

d) The relation between CPUE, indicated by I_y, and the rule's specified TAC before the operation of the minimum change threshold, indicated by TAC'_{y+1}, is given in *Figure E* and in the equations below:

$$TAC'_{y+1} = \begin{cases} \max\left(0, \left(1053 - 1.2\left(1.9 - I_y\right)\frac{1053}{1.9}\right)\right), & \text{for } I_y < 1.9, \\ 1053, & \text{for } 1.9 \le I_y \le 3.2, \\ 1053 + 0.16\left(I_y - 3.2\right)\frac{1053}{1.9}, & \text{for } I_y > 3.2. \end{cases}$$

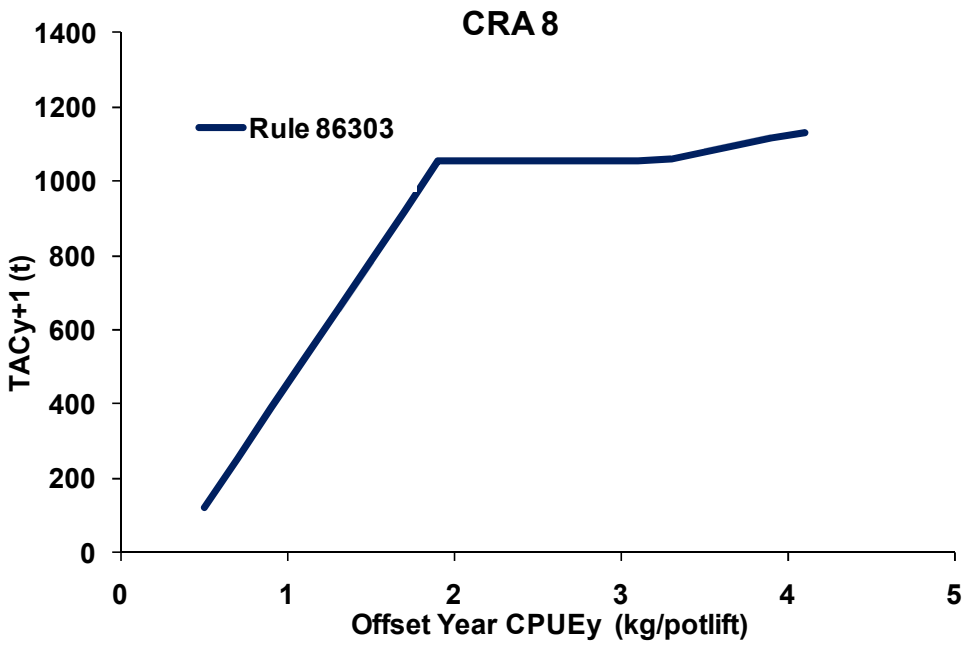


Figure E: The CRA 8 management procedure, showing TAC in year *y*+1 as a function of offset year CPUE in year *y*.

e) The management procedure is to be evaluated every year (no "latent year");

f) If the procedure results in a TAC which changes by less than 5%, no change will be made;

g) There is no limit to the amount by which a TAC may change.

The history of the current CRA 8 Management Procedure is shown in Table E below.

Year	Applied to fishing year	AW CPUE (kg/potlift)	Rule result: TACC (tonnes)	TACC (tonnes)	TAC (tonnes)
2007	2008-09	2.960	1053	966	1053
2008	2009-10	3.844	1110	1019	1110
2009	2010-11	3.781	1110	1019	1110
2010	2011-12 (proposed)	3.107	1053	*To be determined*	*To be determined*

Table E: History of the current CRA 8 Management Procedure, showing proposed limits to the commercial fishery. The "Rule result" is the result of the management procedure after operation of all its components including minimum and maximum change thresholds.

The NRLMG recommends that a review of the management procedure should take place in 2012. This is because management procedures should not remain in place for longer than about five years without a review, because in five years the operating model used to evaluate management procedures will be obsolete and fishery performance should be re-evaluated. Such a review was written into the 2002 NSS Management Procedure (Bentley et al. 2003).