INTRODUCTION OF SEAWEEDS INTO THE QUOTA MANAGEMENT SYSTEM ON 1 OCTOBER 2005

CONSULTATION DOCUMENT

8 April 2004

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EXECUTIVE SUMMARY

1 In accordance with s 19(7) of the Fisheries Act 1996, the purpose of this document is to commence the initial consultation process on behalf of the Minister of Fisheries on the proposal for the introduction of seaweeds into the Quota Management System (QMS) on 1 October 2005. This document outlines the proposed Quota Management Areas (QMAs), fishing year, unit of measure and results of assessments of the costs and benefits of QMS introduction.

2 The Ministry of Fisheries (MFish) requests that you provide your written comments in response to this document no later than **11 June 2004**. Please send your written comments to:

Kristin Philbert, Ministry of Fisheries, P O Box 1020, Wellington (04) 470 2585, PhilberK@fish.govt.nz.

INTRODUCTION

1 In accordance with s 19(7) of the Fisheries Act 1996 (the 1996 Act), the purpose of this document is to commence the consultation process on behalf of the Minister of Fisheries on seven seaweed species proposed for introduction into the Quota Management System (QMS) on 1 October 2005. These species are:

- *Macrocystis pyrifera* (KBB)
- *Gracilaria chilensis* (GRA)
- *Pterocladia lucida* (PTE)
- *Lessonia variegata* (LES)
- *Durvillea antarctica* (KBL)
- *Ecklonia radiata* (ECK)
- *Porphyra* spp (PRP)

2 The Ministry of Fisheries (MFish) requests that you provide your comments on the introduction of seaweeds into the QMS, their proposed Quota Management Areas (QMAs), fishing year, unit of measure and results of assessments of the costs and benefits of QMS introduction, as outlined in this document.

3 A further consultation document on other species proposed for introduction into the QMS on 1 October 2005 will be sent to stakeholders in early May 2004. The species or stocks to be discussed in that document are listed in Table 1 below.

Table 1: MFish list of other species to be considered for introduction into the QMS on 1 October 2005

Species (code)	Scientific name	Current Management Areas
Albacore tuna (ALB)	*Thunnus alalunga*	FMAs 1-10
Skipjack tuna (SKJ)	*Katsuwonus pelamis*	FMAs 1-10
Tuatua (TUA)	*Paphies subtriangulata*	FMAs 1-10
Pipi (PPI)	*Paphies australis*	FMAs 1-10
Cockle (COC)	*Austrovenus stutchburyi*	FMAs 1-10
Dredge oyster (OYS)	*Tiostrea chilensis*	FMAs 1-10
Scallop (SCA)	*Pecten novaezelandiae*	FMAs 1-10

4 Because of the administrative timeframe to introduce species or stocks into the QMS on 1 October 2005, MFish requests that you provide your written comments in response to this consultation document no later than **11 June 2004**. Your comments should be in response to the following proposals:

- The results of assessments of the costs and benefits of QMS introduction;
- The QMAs;
- The fishing year; and
- The unit of measure for the expression of Total Allowable Commercial Catches (TACCs) and Annual Catch Entitlement (ACE).

5 Please send your written comments on this document to:

Kristin Philbert, Ministry of Fisheries, P O Box 1020, Wellington (04) 470 2585, PhilbertK@fish.govt.nz

6 MFish will provide final advice to the Minister later this year on whether or not seaweeds and those species outlined in Table 1 will be recommended for introduction into the QMS on 1 October 2005, once consultation has occurred and submissions have been considered.

7 If you have any questions regarding the consultation document, or wish MFish staff to attend a meeting/hui to discuss the information contained in it, you are encouraged to contact Rose Grindley or Allen Frazer:

Rose Grindley, Private Bag 1926, Dunedin (03) 474 2689 GrindleR@fish.govt.nz

Allen Frazer, Private Bag 1926, Dunedin (03) 474 2682, FrazerA@fish.govt.nz

Background

8 There are around 100 species of aquatic life commercially harvested in New Zealand that are presently managed outside the QMS. Since 30 September 1992 there has been a moratorium on the issuance of new non-QMS permits to commercially harvest these species, other than tuna. The permit moratorium was intended to (1) prevent expansion of non-QMS fisheries prior to QMS introduction, (2) avoid the creation of incentives to 'race for catch history', and (3) mitigate risks to stock sustainability. However, the prolonged presence of the permit moratorium has caused some management issues, such as (1) inhibiting the development of new and under-developed fisheries, and (2) preventing MFish from issuing permits to allow fishers to land non-QMS stocks.

9 These issues can be largely remedied by introducing non-QMS fisheries into the QMS, and developing management controls by way of stock management strategies and fisheries plans. For these reasons, the overall fisheries management framework that will be put into effect within the next few years involves the full implementation of the QMS and likely changes to the way any remaining non-QMS fisheries are managed.

10 While MFish supports the introduction of commercially valuable species into the QMS, it should be remembered that introduction would not necessarily lead to expansion of commercial harvests. The QMS meets the 1996 Act's purpose 'to provide for the utilisation of fisheries resources while ensuring sustainability', which includes mitigating the impact fishing activity may have on stocks already considered vulnerable. The requirement to ensure sustainability applies equally to species managed outside the QMS. However, MFish considers that the QMS framework provides better tools for sustainable management, enhancing fisheries for all resource users.

11 The introduction of species or stocks into the QMS allows the Crown to meet its obligation to Māori under the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 (the Settlement Act). The Settlement Act established that the Treaty of Waitangi

Fisheries Commission would be allocated, on behalf of Māori, 20 percent of all quota for further stocks introduced into the QMS.

12 In addition, when management measures are considered, including Total Allowable Catches (TACs) and TACCs, for species or stocks to be introduced into the QMS, consideration will also be given to the Crown's settlements with individual iwi. These settlements contain provisions regarding species prohibited from commercial harvest and rights of first refusal over any residual Crown-held quota for particular shellfish species.

Next Steps

13 The next steps in the process of determining whether seaweeds and the stocks listed in Tables 1 will be introduced into the QMS on 1 October 2005 are as follows:

14 Following the consultation time period, ending **11 June 2004**, MFish will submit final advice and recommendations to the Minister of Fisheries on each stock's QMAs, fishing year, unit of measure and results of assessments of the costs and benefits of QMS introduction.

15 If the Minister agrees that a stock should be introduced into the QMS, then a Declaration Notice will be published in the *Gazette* that will contain the introduction date, QMAs, fishing year and unit of measure.

Outline of the Consultation Document

16 This document was compiled in accordance with s 10 of the 1996 Act, which requires decisions to be based on the best available information and decision makers to consider any uncertainty in the information available and to be cautious when information is uncertain, unreliable, or inadequate. Section 10 states that the absence of, or any uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve the purpose of the Act. Uncertainty or inadequacies of information are noted throughout this document when they arise.

17 The next section of this document, titled 'Quota Management Areas', outlines the statutory obligations and policy principles used by MFish to determine proposed QMAs.

18 A further section explains the methodology used to assess the costs and benefits of introducing species or stocks into the QMS. This section, titled 'Costs and Benefits of Introducing Species into the QMS', also explains improvements made to the decision-making methodology, including a decision path approach, which have been implemented in this document.

19 The remainder of this document consists of the section on seaweeds which are proposed for QMS introduction on 1 October 2005, and includes the following:

- **Summary of Proposals –** summarises MFish's proposals and alternative options for each stock;
- **Assessment of Costs and Benefits –** outlines the results of MFish's assessments

of the costs and benefits of QMS introduction, which considered the best available information, including various reports produced by the National Institute of Water and Atmospheric Research (NIWA) on contract to MFish;

- **Stocks and Areas -** describes the issues considered when proposing QMAs for seaweeds, including issues identified by NIWA in their summary report "Seaweed Species - QMS Introduction" received 4 June 2003;
- **Proposed Quota Management Areas –** outlines MFish's proposed QMAs;
- **Fishing Year** – outlines MFish's proposed fishing year; and
- **Unit of Measure** – outlines MFish's proposed unit of measure.

Quota Management Areas

20 In proposing QMA boundaries, MFish considered the two statutory obligations set out in the 1996 Act:

- As far as practicable, the same QMAs should be maintained for different species (s 19(2)); and
- A separate QMA may be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit (s 19(3)).

21 In addition, MFish has developed a set of principles to assist in defining practicable QMAs, as outlined in Table 2. MFish used the statutory obligations and those principles relevant to seaweeds to propose QMAs it considers being sensible and effective as long-term stock management boundaries.

Table 2: Principles in setting proposed QMAs

	PRINCIPLES	FISHERIES MANAGEMENT OUTCOMES
1.	Management areas should be based principally on the biological characteristics of the stock.	• Sustainability requirements of the 1996 Act (based around "stock") are met.
2.	The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).	• Sensible stock boundaries. • Simplified allocation of quota. • Reduced business compliance costs.
3.	Where practicable, QMAs for species that are taken together in the same fisheries should be aligned.	• Integrated management of interrelated-stocks. • Reduced complexity and business compliance costs.
4.	QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries.	• Sensible stock boundaries. • Sustainability requirements of the Act are met. • Improved control of harvest and reduced risk to the aquatic environment.
5.	Subject to the principles noted above QMAs should be as large as possible.	• Reduced complexity and business compliance costs. • Flexibility for exercise of customary rights.

22 It is acknowledged that there may be compelling reasons to set QMAs that are different from the boundaries of the biological stock, and, of course biological stock boundaries may not be easy to identify and may vary over time. In some instances it will be appropriate to set a QMA that encompasses more than one biological stock, and move to smaller units of management using the tools in the 1996 Act as more becomes known about the boundaries of a biological stock. Smaller units of management can be implemented using fisheries plans, the QMA subdivision provisions and catch splitting arrangements contained within the 1996 Act. Smaller

units of management may be particularly applicable for some 'sedentary' species. MFish took these issues into consideration when proposing QMAs.

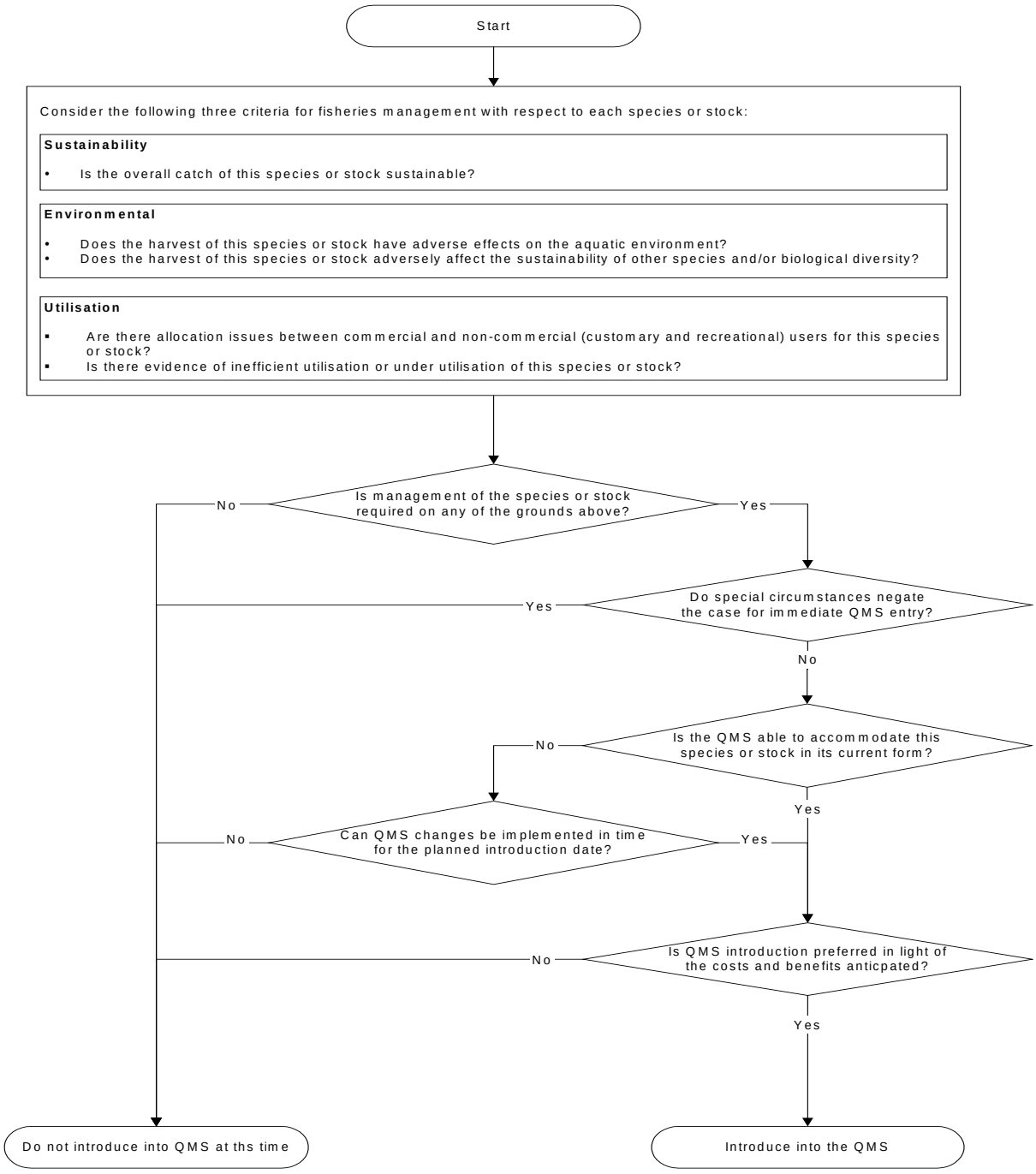
Costs and Benefits of Introducing Species into the QMS

23 Section 19(8) of the 1996 Act requires the Minister of Fisheries to have regard to the costs and benefits of introducing stocks into the QMS. For this reason, MFish undertook assessments of the costs and benefits for seaweeds.

The Decision Path

24 MFish assesses costs and benefits with the use of the decision path which is designed to illustrate the analytical process used on the matters that are important for the species or stock under consideration. The decision path is based on three key criteria that reflect the obligations outlined in the 1996 Act: stock sustainability; environmental effects of fishing on biodiversity and the aquatic environment; and utilisation.

Figure 1 The Decision Path for Cost/benefit Assessments



Guidelines for the decision path

25 The three criteria (sustainability, environmental and utilisation), and their corresponding questions, as outlined at the top of the decision path, are considered together when concluding whether or not active management is required.

26 Should active management of a species or stock be required, the right-hand side of the decision path leads to consideration of QMS introduction. The first decision point on the right-hand side concerns 'special circumstances', which asks, in light of the generic case for the QMS as the management framework of choice, are there any special circumstances that are unusual or are likely to negate the generic case?

27 If there are no special circumstances that would negate the generic case for QMS introduction, then consideration is given to the next two decision points with respect to the QMS' ability to accommodate the species or stock. Such consideration includes identifying required changes to the QMS, if any, and the timing of the changes.

28 Should the QMS in its current form be able to accommodate the species or stock, then the last decision point sets out conclusive statements regarding the costs and benefits of introducing the species or stock into the QMS.

29 Should the results of the cost/benefit assessments demonstrate uncertainty regarding the requirement for active management, the left-hand side of the decision path is followed. In this situation, MFish proposes either that the species or stock not be introduced into the QMS, or QMS introduction be reconsidered in the future at such time as more definitive sustainability or utilisation issues may be identified that warrant active management.

30 However, for consultative purposes, MFish has also completed the right-hand side of the decision path for those species or stocks MFish proposes not to introduce into the QMS or those that MFish has no preference regarding the two options proposed; either QMS introduction on 1 October 2004 or reconsideration in the future.

Preference for QMS introduction

Purpose

31 The purpose of this portion of the Costs and Benefits section is to outline the generic, or general, argument in favour of introducing species or stocks into the QMS. As noted, this argument forms the basis to the species-specific cost/benefit assessments. To assist in understanding of the general argument for QMS introduction, the argument begins with a brief description of the issues relevant to ensuring effective fisheries management occurs and then outlines the shortcomings of the non-QMS framework.

The fisheries management problem

32 The initial state of any fishery is common property freely accessible to whomever desires to extract its value, or stream of benefits. So long as the overall harvest level remains low, there will be no scarcity of benefits that fishers can derive from the fishery. The commonly cited 'tragedy of the commons', however, presumes that this type of free-for-all open access will inevitably lead to degradation of the fishery, leading to its collapse and the erosion of benefits to fishers.

33 The tragedy is presumed to be inevitable because participants lack any incentives to limit their harvest of the fishery. Should any fisher choose to constrain his or her harvest in order to benefit the future of the fishery, the lack of constraint on access allows others to reap any resulting benefits. It is, therefore, presumed that each fisher will harvest as much as possible while having little regard for the future state of the fishery, thus ensuring its eventual degradation.

34 The central problem of fisheries management is to avoid the 'tragedy of the commons' by rationing access once fishers begin to compete for the scarce value, or benefits, derived from a fishery. The central problem is not remedied unless rationing access limits harvest to sustainable levels.

35 In time virtually all fisheries become susceptible to this central problem, potentially affecting both commercial and non-commercial fishers alike. Traditionally, Māori fisheries management limited access and use of a fishery in a number of ways, one of which, kaitiaki remains as an integral part of customary fishing regulations.

36 More generally, prior to 1986 various management measures have been used unsuccessfully to address the central problem. The QMS was implemented in 1986 to address the problem that had become severe for a number of inshore commercial fisheries. The QMS was further improved as a management framework with the enactment of the 1996 Act. The 1996 Act brought about improved sustainability measures and the balancing regime that provides commercial fishers with incentives to control their catch to the level of their quota holdings. The purpose of the Act requires decision makers to address the central management problem by providing for utilisation whilst ensuring sustainability. The purpose of the Act (s 8) is outlined as follows:

a) The purpose of the Act is to provide for the utilisation of fisheries resources while ensuring sustainability.

b) In this Act –

'Ensuring sustainability' means –

i) Maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations; and

ii) Avoiding, remedying or mitigating any adverse effects of fishing on the aquatic environment:

'Utilisation' means conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic and cultural wellbeing.

37 Enabling people to provide for their wellbeing must entail (at the least) the provision of the opportunity for utilisation. To deny access is to disable the ability of a class of people to provide for their wellbeing, which is contrary to the utilisation obligation in the Purpose of the 1996 Act. MFish considers that providing open, or unrestrained, access to stocks is consistent with this utilisation obligation. There are few constraints on access for recreational and customary uses, other than for sustainability concerns and allocations between sectors. This intent, in relation to commercial fishing, is expressed in s 91 of the Act, which states "the chief executive must issue to every person who applies for a fishing permit under this Act an appropriate fishing permit …"

38 However, in an open access environment there is a need to actively manage stocks once they become scarce so that people can provide for their wellbeing in the long term.

39 The current moratorium on issuing new fishing permits prevents open access to fisheries for commercial use. However, the requirement to actively manage the stocks

covered by the moratorium remains because those with fishing permits can increase effort and catch, while non-commercial use can also increase. MFish has identified three inter-related key criteria that indicate when active management is required. These criteria are based on concerns about:

- Stock sustainability;
- Effects of fishing on biodiversity and the aquatic environment; and
- Utilisation, particularly when the fishery has allocation-related problems or development opportunities that impact on the ability of people to provide for their wellbeing.

40 Once the requirement for active management has been identified for a species or stock, then consideration is given to the most appropriate management framework. There are two types of frameworks available under current legislation, the QMS and non-QMS. MFish does not consider the non-QMS framework best enables people to provide for their wellbeing whenever a stock becomes scarce.

41 The non-QMS framework does not ration commercial access to a fishery, except by way of the current permit moratorium, because fishing permits are granted upon request. The non-QMS framework also fails to allocate access rights between generations, which inherently results in claims of unfairness. This failing of the non-QMS framework requires the Government to intervene in the resolution of any future access issues.

42 As the non-QMS framework does not normally define commercial fishers' catch from year to year, it fails to provide them with incentives to maximise the value of a fishery, which then inhibits investments and impedes consideration of management for the future.

43 The non-QMS framework can restrain individual catch levels, and therefore manage stocks sustainably, through a combination of input controls, such as area closures and gear and method restrictions. The non-QMS framework also includes the ability to set a CCL, which is a ceiling on the level of commercial harvest of a fishery.

44 However, the setting of a CCL can exacerbate adverse impacts on the fishery and aquatic environment when competition within the fishery becomes excessive. In this situation, a CCL creates an 'olympic style' fishery whereby fishers compete for access until the CCL is reached. The time fishers have to 'race to catch fish' is constrained more as harvest effort increases.

45 A CCL can have a different effect on a bycatch fishery. In the event the bycatch is taken as an inevitable consequence of a target fishery, and the bycatch fishery CCL has been reached, causing the fishery to be closed, access to the more valued target fishery may then be constrained, thus reducing its value to fishers. However, a CCL applied to a bycatch fishery can also cause a 'race to catch' the target species before the fishery is closed due to the bycatch CCL being reached.

46 Fishers typically respond to a CCL or regulatory input controls by investing in vessels and/or gear that circumvent the intended effect of imposing the regulations. The consequence is that the fishery becomes over-capitalised and inefficient, and, therefore, impacts on peoples' ability to provide for their wellbeing.

47 The non-QMS framework's most effective tool for addressing the management problem is the implementation of Individual Catch Entitlements (ICE). ICE avoids the 'race to catch fish' by allocating a proportion of the CCL to each incumbent. However, the allocation to incumbents precludes new entrants, which is considered to be contrary to the purpose of the 1996 Act and may be ultra vires in an open access environment.

48 ICE lacks divisibility, which means that incumbents are allocated a defined proportion of the CCL that cannot be divided more narrowly. ICE also lacks transferability, which precludes incumbents from divesting of their ICE or investing in more. The consequence is that incumbents may not have access to the level of harvest necessary to maximise the value of the fishery. The lack of transferability also makes ICE unable to allocate access rights between generations, which mean that any claims of unfairness are left to the Government to resolve.

49 The 1996 Act does not provide guidance on the legitimate purpose for which ICE may be used. MFish contends that ICE should be implemented solely for fisheries management purposes. However, there are provisions within the 1996 Act that allow ICE to be translated into quota, which MFish considers to be a far superior access right for the reasons outlined above and others outlined later in this document. MFish also contends that ICE should not be implemented for the purpose of circumventing the quota allocation provisions in the 1996 Act.

50 The non-QMS framework does not provide the same level of flexibility as the QMS on the matter of overfishing. MFish notes that current access arrangements and fishing practices for non-QMS stocks rely on the continuation of the permit moratorium and retention of the s 89(2A) transitional provision that allows the taking of inevitable bycatch species. Section 89(2A) is scheduled to expire on 30 September 2004, as set out in the 1996 Act.

51 As of 1 October 2004, s 241 will be the only means of recognising that in some cases capture cannot be avoided, however, these provisions provide a limited number of defences to taking fish without authority (a fishing permit). MFish's analysis of these provisions suggests that in some situations fishers may need to avoid the areas in which non-target stocks occur in order to provide sufficient evidence against potential prosecution.

52 MFish contends that leaving species subject to the permit moratorium is inconsistent with the purpose of the 1996 Act. The Act requires that utilisation of fisheries resources is provided for. MFish's preferred approach is to remove the permit moratorium. The Fisheries Amendment Bill No 3 has recently been introduced to Parliament. Amongst other things, the Bill proposes that the permit moratorium is lifted, except for species listed on the "Transitional Schedule" to the Bill. The Transitional Schedule lists stocks which the government considers could not be managed sustainably outside the QMS with existing controls, once the moratorium is removed, and those stocks for which catch history will used to allocate quota following 1 October 2004.

53 Although no decisions have been made on this matter, the assessments of costs and benefits of QMS introduction outlined in this document consider the effect that lifting the permit moratorium would have on the stocks in question.

Argument in favour of the QMS

54 MFish considers the QMS to be the best framework available within the 1996 Act to provide for the utilisation of fisheries resources while ensuring sustainability. MFish's preference for the QMS is based on the management tools available within the 1996 Act and the characteristics of quota, which make it a more desirable commercial access right than the non-QMS fishing permit. When the available management tools are combined with the allocation of quota, the QMS becomes a powerful framework for addressing the central management problem outlined above and other consequential management problems. The remainder of this section presents the generic argument in favour of the QMS by outlining why it best meets the sustainable utilisation purpose of the 1996 Act.

Sustainability

55 The 1996 Act requires stocks to be sustained in order to meet the needs of future generations. The sustainability requirement holds whether stocks are managed within or outside the QMS. However, as mentioned, MFish considers the QMS best ensures stock sustainability because of its useful tools (particularly the balancing regime) and incentives (via quota allocations), neither of which are present in the non-QMS framework.

56 The balancing regime strongly discourages the over catch of a TACC while at the same time providing flexibility for those times when catch of a species cannot be avoided, and the fisher does not have authority to catch the species. Overfishing is controlled by graduated administrative incentives based around the payment of deemed values. Over-fishing thresholds, and the ability to restrict harvest via legislative conditions imposed on fishing permits for both QMS and non-QMS stocks, act to prevent fishers who have over caught their ACE from fishing in areas where over catch raises particular sustainability concerns.

57 MFish considers that interactions within multi-species fisheries can be better managed within the QMS than under a CCL regime. Introduction of all stocks that require active management will result in the price of quota for target stocks being based, in part, on the price of quota for bycatch stocks. While this outcome may add operating costs in a mixed fishery, it will focus incentives on the management of species groups, rather than solely on target stocks. Furthermore, this situation will require fishers to face more accurate costs of their operations' impacts on bycatch stocks. Where sustainable catch limits for bycatch stocks constrain the catch of target stocks, stock value and vulnerability will need to be considered together. Fishers will have increased incentives to minimise their catch of vulnerable stocks, or their impacts on the aquatic environment, by adopting environmentally sensitive technologies and fishing practices.

58 MFish considers that the level of information on stocks and harvest effort will be improved in the QMS environment because of the incentives created by quota allocations, particularly in undeveloped and under-developed fisheries that are likely to be 'proved up' in order to substantiate any consideration of increasing harvest levels. Improvements in the level of available information should also benefit the long-term sustainability of stocks and the environment.

59 QMS introduction should incline commercial fishers to take more interest in the management of fisheries, given their investments. MFish continues to advocate the development of fisheries plans to improve the management of fisheries, and notes that quota allocations can facilitate the formulation of participant-initiated management arrangements. The incentives quota holders have to take an interest in a fishery's management, coupled with non-commercial interests, may prove invaluable in the long-term management of the fishery.

Utilisation

60 MFish considers that because the QMS better provides for sustainable utilisation, it is the best framework for enabling people to provide for their social, cultural and economic wellbeing. In particular, the allocation of quota provides a significantly better access right than non-QMS fishing permits because it is based on a secure proportion of the TACC allocated in perpetuity. Commercial fishers can retain indefinitely their proportions of the TACC, thus providing certainty and security when planning long-term operations and investments. Quota's security of tenure provides a means of capitalising the value of future harvesting rights in the fishery. The possibility of trade makes this capital value an asset that holders will wish to enhance.

61 The QMS provides the best opportunity for people to pursue economic wellbeing by allowing quota to be purchased by the most efficient users of the resource. Because quota is divisible, meaning that it can be divided more narrowly, fishers can match quota holdings with their operations through buying and selling. Similarly, the transferability of quota allows less efficient users to exit a fishery by selling their quota and receiving a return on their investment. Lastly, quota's tradability provides the means for inter-generational transfers. The QMS allows for a smooth re-allocation of access rights, via quota trading, from one generation to the next without requiring Government involvement.

62 The cost to commercial fishers of introducing a stock into the QMS is largely a function of the QMAs and catch limits set. TACCs are not set until just before QMS introduction. However, MFish notes that the socio-economic impact of any proposed TACC is a factor relevant to the Minister's consideration of any proposed catch limit.

63 QMS introduction is generally preferred because it facilitates the entry of Māori into commercial fisheries and allows the means for the Crown to meet its obligations to Māori under the Deed of Settlement 1992. Currently, transferable commercial access to Māori is not available under non-QMS management.

64 Although no trade in quota occurs between customary and recreational users, it is expected that these user groups benefit from QMS stocks being sustainably managed and from the Minister considering their interests when setting the TAC and allowances. As well, since customary and recreational groups have an explicit allowance for a stock, they are in a better position to provide their input into its management by way of a fisheries plan or other means. Generally, there are no costs to customary and recreational users for the introduction of a stock into the QMS. However, the implementation of a new TACC may impinge on their utilisation aspirations. The overall benefits of QMS introduction for the customary and

recreational users are derived from improvements to the species or stock's management.

65 Most commercially valued stocks were introduced into the QMS in the mid-1980s to early 1990s, a time when there was a need to rationalise effort in fully- or over-developed fisheries. MFish seeks to avoid some of the problems that have occurred when fisheries have been allowed to develop outside the QMS. For this reason, MFish considers that it would be preferable for QMS introduction to occur soon after a fishery has been identified as having commercial development potential, and sufficient information is available on which to base stock determinations and initial management controls.

66 While there may be some increased costs associated with the introduction of an undeveloped or under-developed fishery into the QMS, these costs would most likely be offset by the long-term investment opportunities made available once a proportion of the TAC has been allocated for commercial use.

67 The allocation of costs by way of cost recovery levies is largely driven by:

a) The level at which TACs and TACCs are set, or estimated catch for species without a TACC;

b) The port price for that species; and

c) Species-specific research.

68 Where a non-QMS species was previously not charged cost recovery levies, there will be an increased cost to that species upon QMS introduction equal to the cost recovery levies. Where a non-QMS species was previously charged levies, and the estimated catch in the levy model is equal to the TACC, then other things being equal, there will be no cost increase from cost recovery levies. Should the TACC for a new QMS species be higher than the previous non-QMS catch limit, in the event one pre-existed, the proportion of costs recovered through levies would increase. Similarly, should an increase in research occur for the QMS species, levy charges would increase.

69 The process for setting TACs, TACCs and allowances occurs approximately six months after the decision is made about QMS introduction.

SEAWEEDS (KBB, LES, KBL, PRP, GRA, PTE, ECK, SEG9 / SEG1-9)

Summary of Proposals

1 MFish proposes that:

a) The following seven seaweed species be introduced into the QMS on 1 October 2005: *Macrocystis pyrifera* (KBB), *Gracilaria chilensis* (GRA), *Pterocladia lucida* (PTE), *Lessonia variegata* (LES), *Durvillea antarctica* (KBL), *Ecklonia radiata* (ECK) and *Porphyra* spp (PRP) but for QMA9-only, that all seaweeds be introduced into the QMS as a single stock (SEG9).

b) The QMAs for the seven species of seaweed ((a) above) are:

KBB1[1], KBB2, KBB3A (boundary statistical area 022/024 to FMA3/7 boundary), KBB3B (rest of FMA3), KBB4, KBB5, KBB7A (boundary statistical area 035/036 to boundary of FMA5/7), KBB7B (rest of FMA7), KBB8.

LES1, LES2, LES3A (boundary statistical area 022/024 to FMA3/7 boundary), LES3B (rest of FMA3), LES4, LES5, LES7A (boundary statistical area 035/036 to boundary of FMA5/7), LES7B (rest of FMA7), LES8.

KBL1, KBL2, KBL3A (boundary statistical area 022/024 to FMA3/7 boundary), KBL3B (rest of FMA3), KBL4, KBL5, KBL7A (boundary statistical area 035/036 to boundary of FMA5/7), KBL7B (rest of FMA7), KBL8.

PRP1, PRP2, PRP3A (boundary statistical area 022/024 to FMA3/7 boundary), PRP3B (rest of FMA3), PRP4, PRP5, PRP7A (boundary statistical area 035/036 to boundary of FMA5/7), PRP7B (rest of FMA7), PRP8.

GRA1, GRA2, GRA3, GRA4, GRA5, GRA7A (boundary statistical area 035/036 to boundary of FMA5/7), GRA7B (rest of FMA7), GRA8.

PTE1A (boundary FMA1/9 to boundary stat area 008/009), PTE1B (rest of FMA1), PTE2A (boundary FMA1/2 to boundary stat area 013/014), PTE 2B (rest of FMA2), PTE3, PTE4, PTE5, PTE7, PTE8.

ECK1A (boundary FMA1/9 to boundary stat area 008/009), ECK1B (rest of FMA1), ECK2A (boundary FMA1/2 to boundary stat area 013/014), ECK2B (rest of FMA2), ECK3, ECK4, ECK5, ECK7A (boundary statistical area 035/036 to boundary of FMA5/7), ECK7B (rest of FMA7), ECK8.

The QMA for SEG9 is FMA9.

2 Alternatively, MFish proposes that:

a) All seaweeds in all QMAs be introduced into the QMS as single stocks (SEG1-9).

b) The QMAs for SEG1-9 ((a) above) are FMAs1-9.

[1] Unless specified numeric values correspond to FMAs

3 For both options, MFish proposes that:

a) The fishing year is 1 October to 30 September.

b) The unit of measurement is greenweight.

Background

4 MFish proposes seaweeds[2] be considered for introduction into the QMS. The proposal is driven by the requirement under the Act to provide for the utilisation of fisheries resources while ensuring sustainability and MFish's assessment that in the case of at least some seaweed species, careful, active, management is required to achieve this.

5 Appendices to this document contain background information on the current statutory regime for seaweeds and the biological and fishery characteristics of the seaweed species proposed for QMS entry.

Key Issues

6 The following key issues arise in considering introducing seaweeds into the QMS.

Large number of seaweed species

7 There are estimated to be at least 800 species of seaweed in New Zealand. At present, there are only a limited number of species of commercial interest. Based on landings, existing permits and information on commercial activity, and the value of seaweed products, MFish considers that seaweed species of immediate commercial interest are *Macrocystis pyrifera*, *Gracilaria chilensis*, *Pterocladia lucida*, *Porphyra* spp, *Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica*. While information on seaweed biomass is sketchy, *Macrocystis pyrifera, Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica* make up a large proportion of New Zealand's seaweed biomass.

8 None of the remaining 800 or so species are currently commercially targeted and most are small and/or sparsely distributed. Nevertheless, in the medium to long term some of these may be harvested as their economic or other value increases, or it may become economically viable to harvest across a range of these species for generic seaweed products (for example, to extract agar or other gelling agents).

9 If the seaweed industry develops in this way, rather than sequentially introducing individual seaweed species into the QMS, it may be appropriate to consider grouping seaweeds for the purpose of future QMS introductions. However, grouping seaweeds along taxonomic or habitat lines is problematic given the range in form and habitat even between related seaweeds. NIWA notes (refer Appendix 2) that grouping seaweeds for the purpose of management is unwise.

[2] The proposals contained in this paper relate to the harvest of 'wild' stocks of seaweed-only. The harvest of seaweed growing[2] on marine or land based farms is not included in this paper. The nature of authorisations required for the harvest and removal of such seaweed is considered as part of the existing and proposed aquaculture legislation.

10 MFish considers the only currently viable alternative to introducing seaweeds at the species level at this time is introduction of a single, undifferentiated, seaweed stock. Under this approach, all seaweeds within a QMA would be introduced into the QMS as a single stock under the code "SEG". Commercial harvest of any seaweed would then require that SEG ACE is held, or payment of SEG deemed values.

11 While such an approach avoids the complications of managing a potentially large number of low value, low volume seaweed species, utilisation of seaweeds is, in most QMAs, differentiated at the species level. For example, fishers target either *Macrocystis pyrifera* or *Pterocladia lucida* (etc); therefore, a regulatory framework based on a single stock approach will make it difficult to balance seaweed utilisation and sustainability objectives. In particular, catch levels for some seaweeds may be unnecessarily restrictive due to the sustainability risks for other species. In the longer term, this disadvantage may be overcome given that there would be incentives for seaweed rights-holders to cooperate and develop finer-scale arrangements under a Fisheries Plan or using other QMS tools.

12 At this time, MFish's preference is to manage seaweeds at the species level within the QMS, rather than as a single stock (except in QMA9 – see below). However, the second option could be considered if favoured by stakeholders. Its viability largely depends on the capacity of seaweed rights-holders to cooperate. MFish seeks stakeholder views on these issues.

The QMA9 green-lipped mussel fishery

13 In QMA9, a range of seaweed species provides the primary substrate for settlement of pelagic green-lipped mussel spat. Predominant use of seaweeds is as a 'bycatch' of the green-lipped mussel spat fishery and, therefore, seaweeds are not differentiated into species when taken.

14 The green-lipped mussel fishery is being introduced into the QMS on 1 October 2004. Given the inter-related nature of seaweeds and green lipped mussel spat, the importance of green-lipped mussel spat from this area in terms of New Zealand's aquaculture industry, and that existing use of seaweeds in QMA9 does not lend itself to separate species management, MFish proposes all seaweeds in QMA9 be introduced into the QMS as a single stock. The commercial harvest of any seaweed in QMA9 would then require that SEG ACE is held, or payment of SEG deemed values. Managing all seaweeds in QMA9 as a single stock avoids the need to separate individual seaweed species for reporting purposes.

15 As the seaweed fishery in QMA9 is currently of low value, seaweed has most value as a bycatch and settlement substrate for green-lipped mussel spat. Consequently, green-lipped mussel spat fishers will value seaweeds more highly than other seaweed users in QMA9 and will acquire the majority of QMA9 seaweed quota and ACE. MFish notes there is little or no catch history for seaweeds in QMA9.

16 Should valuable target fisheries develop for seaweeds in their own right in QMA9, then, MFish notes there are tools within the QMS to manage seaweeds with specific reporting codes or on a specific or fine-scale basis should this be necessary.

Bycatch of seaweeds

17 A further complicating factor for seaweeds is that they are often taken as an unwanted incidental 'bycatch' when entangled in fishing gear. MFish considers it will be appropriate to include these species on the Sixth Schedule to allow them to be returned to the sea (rather than landed, which is the default for QMS species). However, this will not be finally determined until sustainability and other management measures for seaweed are considered next year.

Different seaweed states

18 As described in the following assessment of cost and benefits of QMS introduction, there is a hierarchy in terms of sustainability and other risks for seaweed species with respect to their state, with the harvest of attached seaweeds generally presenting the most risk and the harvest of free-floating and beach-cast seaweeds of relatively less concern. This means the case for active management of beach-cast seaweed is less strong. However, MFish considers that difficulties in determining the state in which seaweed has been taken will cause significant compliance difficulties if the states are managed on a separate basis. For example, if it is not possible to determine if the seaweed has been taken when beach-cast, or attached, then the attached stock is at risk from illegal unsustainable harvesting. Therefore, MFish favours introducing all states of seaweed into the QMS.

19 The different levels of risk associated with harvesting the different states of seaweed suggest different sustainability settings may be appropriate within the QMS. Managing all states of a species together will present challenges in terms of providing for utilisation across all states at an appropriate level, since sustainability settings (for example TACs) are likely to be driven by the most vulnerable attached state. For example, TACs for reef-forming species such as *Macrocystis pyrifera, Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica* will need to reflect potential adverse impacts from cutting these species on the aquatic environment, other species and biological diversity.

20 Sustainability and other management settings for seaweeds will not be determined until next year, should introduction of these seaweed species into the QMS proceed. However, as a preliminary position, MFish considers the introduction of seaweeds into the QMS may need to be supported by a regulatory environment initially restricting the cutting of these four reef-forming seaweed species. This would allow sustainability settings (such as TACs) for these species to be set at levels commensurate with the level of risk associated with harvesting their less vulnerable free-floating and beach-cast states. The restrictions can then be reviewed on a species or area basis as seaweed quota-holders or other stakeholders address the sustainability and other risks associated with harvesting these reef-forming seaweeds[3].

Deed of Settlement obligations for seaweeds

21 Seaweeds are an important element of customary fishing and some seaweed species, in some areas, are included as prohibited non-commercial species in Deeds of

[3] If the cutting restriction extended to reef-forming non-QMS seaweeds it would also avoid sustainability issues arising for those species, which, depending on the outcome of proposed amendments to the non-QMS permit moratorium (refer introduction section), will by then be managed under open access arrangements.

Settlement of Mäori Claims. Sustainability and other management measures for seaweed will also be required to give effect to these prohibitions.

Reporting and identification of seaweeds

22 As with all QMS introductions, species/stock reporting codes will need to be refined to ensure the codes correctly identify the appropriate QMS seaweed species/stock. Work is planned to commence shortly on an identification guide for fishers for new QMS stocks. This guide will include any seaweeds being introduced into the QMS at the species level.

Transitional arrangements

23 MFish has requested Parliament to amend the permit moratorium from October 2004 to allow seaweeds and other non-QMS species to be taken under authority of a fishing permit. For the period between October 2004 and October 2005 (when seaweeds are proposed to enter the QMS) MFish is considering whether to recommend the attached state of the seven species proposed for QMS introduction remain subject to the moratorium. For QMA9 (90 Mile Beach), MFish is proposing that current restrictions on beach-cast seaweed harvesting under the Fisheries (Beach Cast Seaweed Area Prohibition) Notice 2002 to be removed to ensure that the harvest of juvenile green-lipped mussel (which will be taken under quota from 1 October 2004) is not unnecessarily constrained[4].

Assessment of costs and benefits

24 Before introducing a stock into the QMS, the Minister must have regard for the costs and benefits of its introduction. An assessment of the expected costs and benefits of introducing seaweeds follows.

Sustainability criteria

Is the overall catch of this species or stock sustainable?

25 Information on seaweed taken under fishing permit during the 2001-02 fishing year is set out in Table 1 below.

Table 1. Reported catch of seaweed for the fishing year 2001-02

Species Caught	Fishing Year	Total Estimated Catch Weight (kg)
KBB *(Macrocystis pyrifera)*	2001-02	106 206
KBL *(Durvillea antarctica)*	2001-02	3,805
LES *(Lessonia variegata)*	2001-02	3,644
PRP *(Porphyra spp)*	2001-02	935
PTE *(Pterocladia lucida)*	2001-02	446
ECK *(Ecklonia radiata)*	2001-02	11 525
SEO *(Seaweed unspecified)*	2001-02	54 650

[4] Setting of Sustainability and Other Management Controls for Stocks to be Introduced Into the QMS on 1 October 2004: Green-lipped Mussel. MFish Initial Position Paper, 9 March 2004.

26 Most of this seaweed is taken when beach-cast, but all *Porphyra* spp and some *Lessonia variegata*, *Durvillea antarctica* and *Pterocladia lucida* is taken from attached seaweed beds. Seaweed taken under special permit by paua farmers is additional to the above figures. Approximately 300t of beach-cast and free-floating seaweed, primarily *Macrocystis pyrifera,* is taken annually under these special permits.

27 A further 250 tonnes of beach-cast and free-floating seaweed and green-lipped mussel spat is taken annually under spat catching permits in QMA9. The collection of green-lipped mussel spat is the predominant use of seaweed in this QMA. Free-floating and attached seaweed is sometimes also inadvertently taken during trawling, potting and set netting (and usually returned to the sea).

28 An unreported amount of red beach-cast seaweed (primarily *Pterocladia lucida* and *Gracilaria chilensis*) is also taken for commercial use under the permit exemption. MFish is unaware of any current harvest of marine and freshwater micro-algae or seagrass in New Zealand[5].

29 A summary of information on seaweeds prepared by NIWA (Appendix 2) includes more detailed information on seaweed catch at a species level.

30 Seaweeds are important components of most of New Zealand's coastal reefs and inland waterways and the biomass of seaweeds in some areas is very high. Some seaweed species, including *Macrocystis pyrifera*, *Gracilaria chilensis*, and *Porphyra* spp are productive, and successfully harvested on a large scale overseas. Others, such as *Pterocladia lucida*, have been extensively harvested in the past in New Zealand. However, as described in the appendices, seaweed species can be susceptible to overexploitation and unable to sustain significant levels of harvest due to their slow growth rate or morphology.

31 Seaweed is found attached to rocky or other substrates, free-floating and beach-cast. While free-floating seaweed has been detached from the substrate, in some instances it continues growing and reproducing for prolonged periods before being cast ashore and/or decaying. Such seaweed may contribute to the reproductive potential of the seaweed stock from which it is derived, particularly in terms of long-distance reproductive dispersal.

32 Ultimately, a large amount of seaweed ends up being cast ashore. The amount of seaweed material cast ashore at any one time can vary tremendously depending upon storm events, tides, currents and wind direction.

33 The majority of beach-cast seaweed decays rapidly and does not contribute directly to the growth and reproduction of the stock from which it is derived. Therefore, there is considered to be little direct link between harvest of beach-cast seaweed and the sustainability of the attached seaweed stock from which it is derived, and MFish does not consider there to be a current sustainability issue with respect to beach-cast seaweed. Given that beach-cast seaweed is already excluded from the permit

[5] 'Seaweed'[5] under the Fisheries Act as: "…all kinds of algae and sea-grasses that grow in New Zealand fisheries waters at any stages of their life history, whether living or dead". Refer appendix 1.

moratorium, no additional sustainability concerns are expected to arise when the permit moratorium is lifted.

34 Since 1992, there have been tight constraints on harvesting attached seaweeds as a result of the permit moratorium, therefore, few sustainability issues are currently evident for attached seaweed. However, occasional issues have arisen due to inappropriate harvesting under existing permits or illegal activity. This activity highlights there may be incentives to target commercially valuable species of seaweed when attached to the substrate (rather than beach-cast or free-floating) due to their higher value in this state, and the ease with which attached reefs of seaweed can be located and harvested.

35 MFish considers that an expansion of harvest of commercially valuable seaweed species is likely in the absence of the permit moratorium. Market demand and the ease with which seaweeds can be located and harvested could potentially result in the complete removal of seaweed species from an area. As previously noted, MFish considers that, based on available information, seaweed species of immediate commercial interest are *Macrocystis pyrifera*, *Gracilaria chilensis*, *Pterocladia lucida*, *Porphyra* spp, *Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica*.

Does the harvest of this species or stock have adverse effects on the aquatic environment or adversely affect other species and/or biological diversity?

36 Seaweeds in their attached state are important components of coastal reefs, forming nursery and habitat and food for many marine species. The role of attached reefs of seaweed is considered critical for the recruitment and protection of many commercially important fisheries such as rock lobster, paua and the green-lipped mussel spat fishery, although the interactions and associations are not well understood or documented. In inland waterways, freshwater algae may provide the same function for freshwater fish, invertebrates and crustaceans.

37 Seaweed reefs are also important, structurally, in the inshore coastal area, modifying wave flows and energy.

38 Expansion in harvest of commercially valuable species of attached seaweeds is likely in the absence of the permit moratorium and may result in adverse effects on the aquatic environment, associated and dependent species and biological diversity. As well as potentially removing important canopy-forming seaweeds, such as *Macrocystis pyrifera*, *Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica,*, which are an important structural component of coastal reefs, harvesting could result in long-term changes in seaweed diversity and distribution. For example, inappropriate harvesting of native seaweeds could result in replacement by invasive seaweeds such as *Undaria pinnatifida.*

39 The harvest of commercially valuable seaweed species in their free-floating state is also likely to increase in the absence of the permit moratorium. Seaweed in its free-floating state is a primary food source for paua, kina and other inshore invertebrates. Free-floating seaweed may also provide a means of long-distance dispersal for invertebrates and other aquatic species that use seaweed for habitat and food. Large-scale removal of free-floating seaweed could adversely affect the aquatic

environment, other species and/or biological diversity. Methods used to harvest free-floating seaweeds depend on the species targeted, but include hand-gathering, drag and set nets. In some areas, an increase in use of these methods could adversely affect protected and other species (for example marine mammals and seabirds).

40 There are potential impacts from harvesting beach-cast seaweed on birds and on invertebrates that feed on the strand line or utilise it as habitat. These impacts can arise from removal of the beach-cast seaweed on which these species depend as well as from increased vehicle movement and disturbance associated with harvesting. Beach-cast seaweed may also have a role in stabilising sand dunes and potentially contributes to inshore nutrient cycling.

41 In QMA9, a large range of seaweed species provide the primary substrate for settlement of pelagic green-lipped mussel spat. Large-scale removal of seaweeds in QMA9 could potentially adversely impact the green-lipped mussel spat fishery.

Utilisation criteria

Are there allocation issues between commercial and non-commercial (customary and recreational) users for this species or stock?

42 Recreational fishing surveys have not included seaweeds and, therefore, information on the level of non-commercial seaweed harvest is anecdotal. Some seaweeds are considered to be of high importance for customary fishers and are important to some recreational fishers. Mäori historically used seaweeds such as *Porphyra* spp (Karengo) and other seaweeds for food, and *Durvillea antarctica* (Rimurapa) for storage and other uses. A number of customary fishers have noted the importance of seaweeds as a resource, and while no data on the customary harvest is available, seaweeds remain an important element of customary fishing throughout many parts of New Zealand. This is reflected in the inclusion of certain seaweeds in Deeds of Settlement of Maori Claims[6].

43 Under open access, it is likely commercial fishers will increasingly target commercially valuable species of attached seaweed. As noted earlier, attached seaweed often has a higher commercial value than other forms of seaweed and is easily located and harvested. Given low entry costs for the fishery, there is a risk that increased commercial targeting of attached seaweeds would reduce the amount of seaweeds available to the non–commercial sector, especially in areas where there may be significant non-commercial use.

44 There is little evidence of allocation issues between commercial and non-commercial users in terms of free-floating or beach-cast seaweed at present. Non-commercial use of beach-cast and free-floating seaweed is primarily for the purpose of home composting. Small amounts are also used for decorative and hobby purposes. However, unrestricted harvesting of seaweed (including attached seaweed) could reduce the availability of beach-cast and free-floating seaweed for both commercial and non-commercial users.

[6] For example, the Ngai Tahu Claims Settlement Act 1998 specifies that *Durvillea* spp, *Porphyra columbina* and *Ulva* spp are non commercial species across Ngai Tahu's rohe.

Is there evidence of inefficient utilisation or under utilisation of this species or stock?

45 The current value and scale of seaweed harvesting in New Zealand is low. There is limited information on the likely market demand for New Zealand seaweeds, but MFish considers that harvesting of valuable seaweed species will increase once moratorium constraints are removed, although the commercial harvest of beach-cast seaweed may not.

46 Inefficiencies in commercial use are evident for seaweeds due to insufficient capital investment. The allocation of secure commercial harvesting rights is likely to provide incentives to overcome the many challenges associated with managing seaweed fisheries, particularly those fisheries based on the cutting of attached seaweed.

47 In QMA9, the seaweed fishery is interrelated with the green-lipped mussel spat fishery. The green-lipped mussel fishery is due to enter the QMS on 1 October 2004. With the demand for green-lipped mussel spat expected to increase with the expansion of mussel farming, it is expected that seaweed catches will also increase. Seaweed with attached green-lipped mussel spat is likely to increasingly become economically scarce. The allocation of secure commercial harvesting rights to seaweeds would integrate management of the seaweed fishery with the green-lipped mussel spat fishery and would provide right-holders with the flexibility to decide how best the seaweed resource should be utilised in a sustainable manner.

48 There is currently no excess harvesting capacity for seaweeds, due to the permit moratorium. Under open access, it is likely commercial fishers will increasingly target commercially valuable species of seaweed. There is likely to be a 'race for fish' under these circumstances with over-capacity and inefficiencies likely at some point. The impact of overcapacity may not be significant, however, given the low costs of participation.

Conclusions drawn from the criteria

49 The assessment indicates that there is a hierarchy in terms of sustainability and other risks for seaweed species of commercial interest, with the harvest of these seaweeds in their attached state presenting the most risk and the harvest of seaweeds in their free-floating and beach-cast states of lesser concern.

50 The current permit moratorium constrains harvest of seaweeds except when beach-cast. An expansion in harvesting of commercially valuable species of seaweeds in their attached and free-floating states is likely in the absence of this constraint because beach-cast seaweed generally has a lower value than other states of seaweed.

51 Increased harvesting of attached seaweed, particularly reef-forming species such as *Macrocystis pyrifera*, *Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica,* could adversely affect the aquatic environment, associated species and biological diversity unless carefully managed. As well as removing important canopy-forming seaweeds, which are an important structural component of coastal reefs, harvesting of attached seaweed could result in long-term changes in reef diversity and seaweed distribution.

52 Free-floating seaweeds are an important food source for paua, kina and other inshore invertebrates and may contribute to reproductive dispersal of seaweeds, associated invertebrates and fish. Large-scale removal of free-floating seaweed could adversely affect the aquatic environment, other species and/or biological diversity.

53 There are unlikely to be any current sustainability issues with respect to beach-cast seaweed and, given that beach-cast seaweed is already excluded from the permit moratorium, no additional sustainability concerns are expected to arise when the permit moratorium is lifted. However, there are potential impacts on birds, invertebrates and the aquatic environment from harvesting beach-cast seaweed.

54 Large-scale removal of seaweeds in QMA9 has the potential to adversely impact New Zealand's green-lipped mussel spat fishery.

55 Seaweeds are important to customary and other non-commercial harvesters. Significant increases in commercial harvesting of seaweed could reduce the amount of seaweed available to non–commercial harvesters and result in allocation issues between commercial and non-commercial harvesters.

56 For these reasons, unregulated, open-access management is unlikely to be an appropriate management strategy for commercially attractive species of seaweeds when the permit moratorium is removed. Market demand and the ease with which seaweeds can be located and harvested could result in the complete removal of valuable seaweed species from an area and/or alteration of their recruitment dynamics with long-term changes to their distribution and abundance.

57 Introducing seaweed into the QMS would provide generic property right benefits. The allocation of secure commercial harvesting rights is likely to provide incentives to overcome the many challenges associated with managing seaweed fisheries, particularly those based on the cutting of attached seaweed. Inefficiencies in commercial use are evident for seaweeds due to insufficient capital investment. Secure harvest rights will provide incentives to enhance the value of the seaweed fishery through investment and development of processing and infrastructure. While this presents a case for QMS entry for all states of seaweed, the case for beach-cast seaweed may be less strong given its lower value.

58 The allocation of secure commercial harvesting rights to seaweeds in QMA9 would not only achieve the above benefits but would integrate management of the seaweed fishery with the green-lipped mussel spat fishery.

59 MFish notes the current regime for seaweeds lacks integration and has the potential to cause unnecessary complication in their management and for the activities of commercial participants. MFish proposes that the QMS also has the potential to integrate the management of seaweeds so that the purpose of the 1996 Act is better achieved.

Special circumstances

Do special circumstances negate the case for QMS entry?

60 The above assessment suggests that the harvest of commercially valuable seaweed species requires active management. As noted, MFish proposes that seaweed species of current commercial interest are *Macrocystis pyrifera*, *Gracilaria chilensis*, *Pterocladia lucida*, *Porphyra* spp, *Lessonia variegata*, *Ecklonia radiata* and *Durvillea antarctica*. On this basis, management of these species should occur within the QMS. As described in the "Key Issues" and "Conclusion" sections of this paper, there are complicating factors in terms of the large number of seaweed species found in New Zealand waters and the green-lipped mussel-seaweed fishery in QMA9 that mean that management within the QMS presents challenges. MFish considers these challenges can be met by appropriate settings within the QMS and that there are no special circumstances that would negate the case for QMS entry for seaweeds.

Consideration of the QMS

Is the QMS able to accommodate this species or stock?

61 Yes, the QMS in its current form is able to accommodate the introduction of seaweed.

Can QMS changes be implemented in time for the planned introduction date?

62 No changes are required to the QMS.

Conclusion

Is QMS introduction preferred in light of the costs and benefits anticipated?

63 In light of the above considerations, MFish preliminary assessment is that the benefits of QMS introduction appear to outweigh the costs of introducing the seaweeds into the QMS.

64 The current value and scale of seaweed harvest in New Zealand is low. MFish does not have good information on future market demand for New Zealand seaweeds, but expects that harvesting of the most abundant and commercially valuable species of seaweed will increase once moratorium constraints are removed.

65 Harvesting of these seaweeds, particularly in their attached and free-floating states, can adversely affect the aquatic environment, other species and biological diversity unless carefully managed. MFish considers this management should occur within the QMS given the preference for QMS management described in the generic section of this document. Seaweeds are also important to customary and other non-commercial harvesters. Increased commercial harvesting of seaweed as moratorium constraints disappear would reduce the amount of seaweed available to non–commercial harvesters and result in allocation issues between commercial and non-commercial harvesters.

66 The allocation of secure commercial harvesting rights for these species is likely to provide incentives to overcome the many challenges associated with managing seaweed fisheries, particularly concerning the cutting of attached seaweed.

67 Species of current commercial interest are *Macrocystis pyrifera* (KBB), *Gracilaria chilensis* (GRA), *Pterocladia lucida* (PTE), *Lessonia variegata* (LES), *Durvillea antarctica* (KBL), *Ecklonia radiata* (ECK) and *Porphyra* spp (PRP) and MFish proposes that these species should be introduced into the QMS. MFish considers that other seaweed species are unlikely to be harvested in significant quantities in the short to medium term even in the absence of the permit moratorium. These species could be considered for QMS introduction in the future when interest in commercial harvesting becomes evident.

68 The use of seaweeds in QMA9 is primarily driven by the green-lipped mussel spat fishery. Therefore, the seaweed fishery in this area does not lend itself to separate species management. MFish proposes to introduce all seaweeds in QMA9 into the QMS as a single, undifferentiated, stock. Providing secure harvest rights for all seaweed in QMA9 provides right-holders with flexibility to determine how best to utilise the seaweed resource in a sustainable way. The proposal also allows the integration of the seaweed and green-lipped mussel spat fishery, supported by the proposal to base the seaweed TACC for QMA9 on the required harvest of green-lipped mussel spat to avoid unnecessarily constraining this harvest.

69 MFish proposes the single stock approach may also be a viable alternative for other QMAs, particularly if it is considered that a large number of seaweed species are likely to need to be brought into the QMS in the future. MFish seeks stakeholder views on this option.

70 MFish proposes that the introduction of seaweeds into the QMS may need to be supported by a regulatory environment preventing the cutting of some reef-forming species, for example *Macrocystis pyrifera*, *Lessonia variegata*, *Durvillea antarctica* and *Ecklonia radiata*. This would provide a number of management benefits including greater utilisation of these species in their less vulnerable free-floating and beach-cast states, but would be open to review where risks associated with cutting these species had been addressed. The use of the Sixth Schedule should also be considered to allow unwanted bycatch of seaweed to be returned to the sea. Regulatory proposals will be developed following further consultation next year, should the introduction of seaweeds into the QMS proceed.

Stocks and Areas

71 The summary of information prepared by NIWA (Appendix 2) includes information on the distribution and recommended fishstock boundaries for seven seaweeds proposed for QMS introduction.

72 NIWA advises that *Porphyra* spp includes 35 species all previously thought to be the one species, *Porphyra columbina.* MFish proposes these species be managed within the species grouping *Porphyra* spp. Given that many of these species can only be differentiated by microscopic or molecular sequencing techniques, it is not practical to manage them separately at this time. Management settings within the QMS will,

however, need to take into account the uncertainty regarding actual species composition.

73 Similarly, a cryptic, unnamed, species of *Gracilaria* may be growing alongside *Gracilaria chilensis* in Manukau and Waitemata Harbour. As this species cannot be distinguished from *Gracilaria chilensis* except by molecular sequencing techniques, again MFish proposes this species will be managed as *Gracilaria chilensis* in the QMS.

74 There are also other less abundant species of *Gracilaria, Lessonia, Pterocladia* and *Durvillea*[7], however, these are currently of less commercial interest than the species listed above and are distinguishable from the species proposed to be introduced into the QMS.

75 Like other sedentary stocks introduced into the QMS over the past year (kina, surf clams and sea cucumber), the biological characteristics of seaweeds suggest they should be managed on a small spatial scale and that they are vulnerable to local over-harvesting.

76 MFish considers that QMAs for seaweeds should provide the boundaries within which seaweed quota holders and stakeholders can practice small-scale management and adaptively move to smaller stock management over time, using fisheries plans, alteration of QMAs and other tools within the Act.

Proposed Quota Management Areas

77 The 1996 Act sets out two statutory obligations that must be considered when defining QMAs:

- As far as practicable, the same QMAs should be maintained for different species (s 19(2));
- A separate QMA may be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit (s 19(3)).

78 In addition, MFish has developed a set of principles to assist in defining practicable QMAs, which is set out in the generic section. In considering these statutory obligations and principles, MFish considers the following are key issues in defining QMAs for seaweeds:

- The species proposed for introduction vary considerably in terms of their biology, habitat, distribution and existing fishery. They are able to be target-fished and are not usually taken together in the same fishery. Consequently, it is not necessary to set the same QMAs for different species.
- NIWA notes that spores of most seaweed species do not travel far. Therefore, the biological characteristics of seaweeds suggest they should be managed on a small spatial scale, however, in most cases there is insufficient information to indicate appropriate boundaries for small-scale management.
- MFish prefers to amalgamate QMAs in areas outside the normal range of the

[7] *Durvillea willana* is a non-commercial species across most of its range (refer footnote 4).

seaweed species and where the species is unlikely to be abundant or unable to be targeted. This reduces administrative and business compliance costs.

79 Therefore, the proposed QMAs are based on standard FMAs except where the above statutory directions and principles suggest a subdivision or amalgamation is required.

80 Any areas of potential interest in terms of seaweed harvest in FMAs 6 and 10 are closed to fishing. Therefore, FMAs 6 and 10 are not included in these proposals.

Proposals

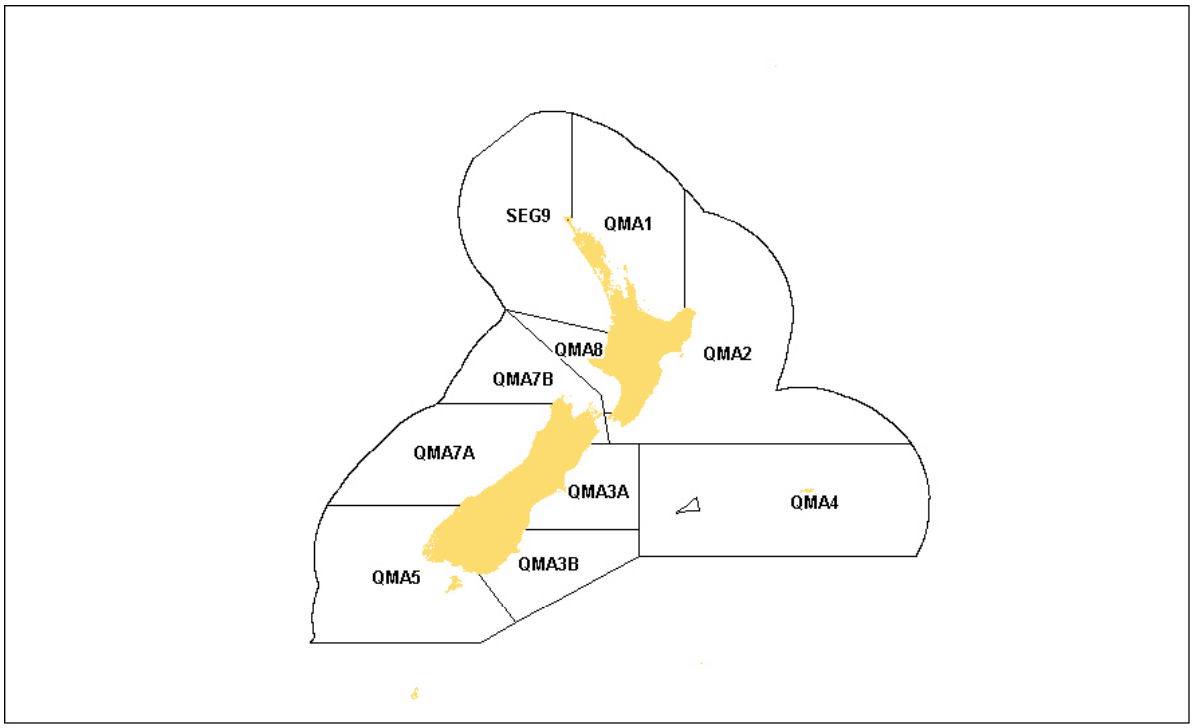
81 MFish proposes FMA9 be the QMA for the single stock SEG9 proposed to be introduced into the QMS.

82 MFish proposes the same QMAs for *Macrocystis pyrifera*, *Lessonia variegata*, *Durvillea antarctica* and *Porphyra* spp, based on standard FMA boundaries for areas where these species are likely to be less abundant, and subdivisions in FMA3 and FMA7 where the species is abundant and where there are natural stock boundaries for these species:

> KBB1[8], KBB2, KBB3A (boundary statistical area 022/024 to FMA3/7 boundary), KBB3B (rest of FMA3), KBB4, KBB5, KBB7A (boundary statistical area 035/036 to boundary of FMA5/7), KBB7B (rest of FMA7), KBB8.
>
> LES1, LES2, LES3A (boundary statistical area 022/024 to FMA3/7 boundary), LES3B (rest of FMA3), LES4, LES5, LES7A (boundary statistical area 035/036 to boundary of FMA5/7), LES7B (rest of FMA7), LES8.
>
> KBL1, KBL2, KBL3A (boundary statistical area 022/024 to FMA3/7 boundary), KBL3B (rest of FMA3), KBL4, KBL5, KBL7A (boundary statistical area 035/036 to boundary of FMA5/7), KBL7B (rest of FMA7), KBL8.
>
> PRP1, PRP2, PRP3A (boundary statistical area 022/024 to FMA3/7 boundary), PRP3B (rest of FMA3), PRP4, PRP5, PRP7A (boundary statistical area 035/036 to boundary of FMA5/7), PRP7B (rest of FMA7), PRP8.

[8] Unless specified numeric values correspond to FMAs

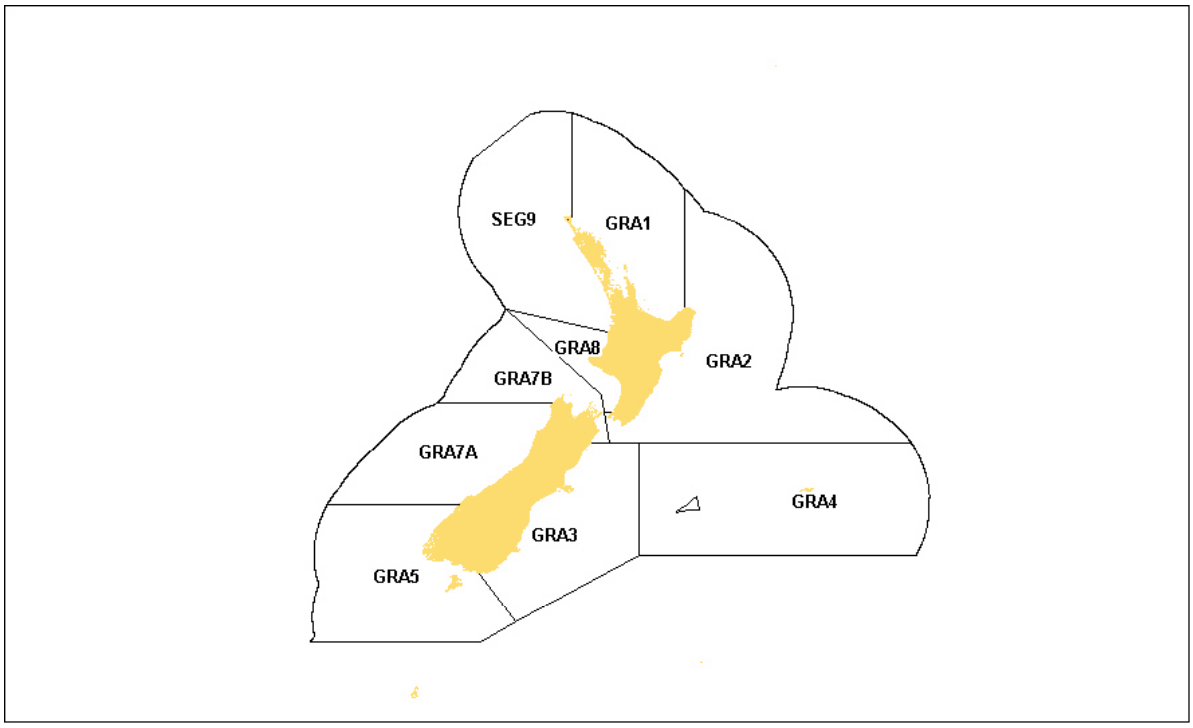
Figure 1: Quota Management Areas for KBL, KBB, LES, PRP



83 MFish proposes the following QMAs for *Gracilaria chilensis*, based on standard FMA boundaries except where there is a natural stock boundary (FMA7):

GRA1, GRA2, GRA3, GRA4, GRA5, GRA7A (boundary statistical area 035/036 to boundary of FMA5/7), GRA7B (rest of FMA7), GRA8.

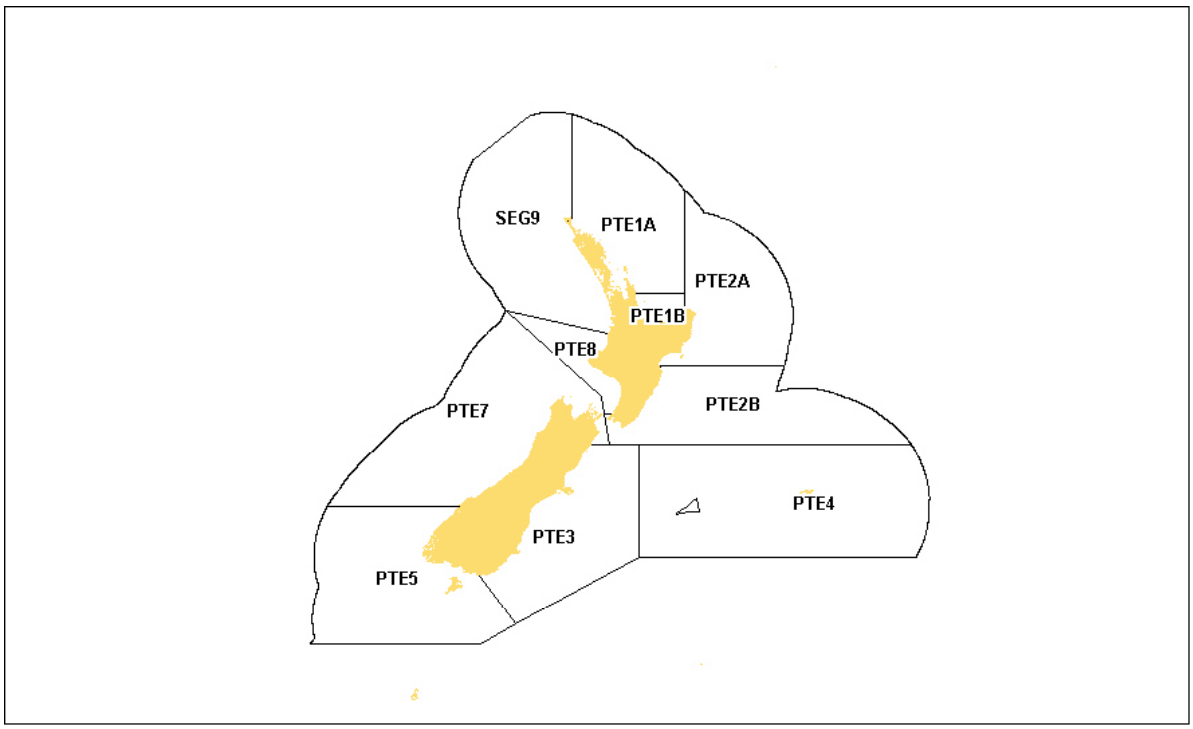
Figure 2: Quota Management Areas for GRA



84 MFish proposes the following QMAs for *Pterocladia lucida* based on standard FMA boundaries except where there is a natural stock boundary (FMA1):

> PTE1A (boundary FMA1/9 to boundary stat area 008/009), PTE1B (rest of FMA1), PTE2A (boundary FMA1/2 to boundary stat area 013/014), PTE 2B (rest of FMA2), PTE3, PTE4, PTE5, PTE7, PTE8.

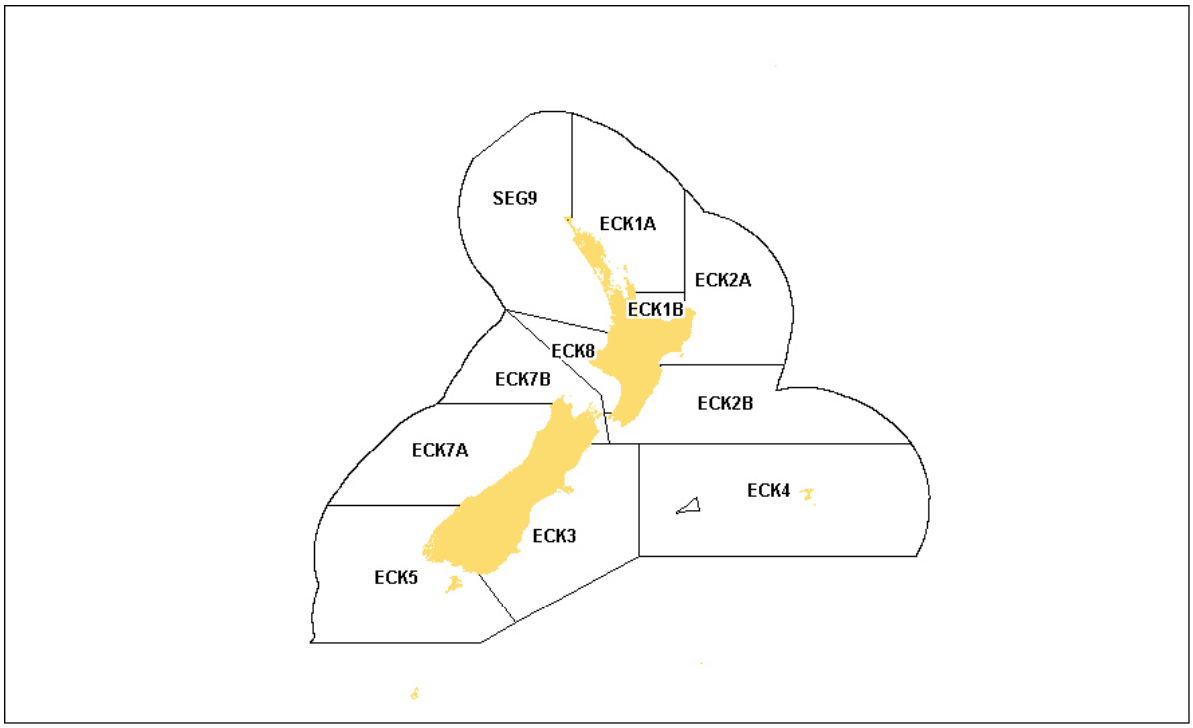
Figure 3: Quota Management Areas for PTE



85 MFish proposes the following QMAs for *Ecklonia radiata* based on standard FMA boundaries except where there are natural stock boundaries (FMA1 and FMA7):

> ECK1A (boundary FMA1/9 to boundary stat area 008/009), ECK1B (rest of FMA1), ECK2A (boundary FMA1/2 to boundary stat area 013/014), ECK2B (rest of FMA2), ECK3, ECK4, ECK5, ECK7A (boundary statistical area 035/036 to boundary of FMA5/7), ECK7B (rest of FMA7), ECK8.

Figure 4: Quota Management Areas for ECK



MFish proposes FMAs1-9 be the QMAs if the single stock alternative (SEG1-9) is implemented.

Fishing year

87 Apart from the green-lipped mussel spat fishery in QMA9, the seaweed species proposed to be introduced into the QMS are not significantly associated with any other fisheries. The green-lipped mussel fishery is to be managed under a 1 October to 30 September year from 1 October 2004, therefore, MFish proposes a 1 October to 30 September year be used for the SEG9 stock.

88 For other seaweeds the fishing year could be either 1 October to 30 September or 1 April to 31 March. MFish proposes 1 October to 30 September be used to allow management within the QMS from the earlier date of 1 October 2005 and to provide consistency with SEG9.

Unit of Measure

89 MFish considers that the unit of measure for seaweeds should be greenweight. There are practical issues in terms of obtaining consistent measurement of seaweed landings. MFish considers these issues will arise irrespective of the unit of measure. As with other fisheries, seaweeds are required to be weighed as soon as practicable after harvest.

APPENDIX ONE – DEFINITIONS AND CURRENT MANAGEMENT REGIME FOR SEAWEEDS

1 'Seaweed'[1] is defined under s 2 of the Act as:

> *"…all kinds of algae and sea-grasses that grow in New Zealand fisheries waters at any stages of their life history, whether living or dead".*

2 'Beach cast seaweed' is defined under s 2 of the Act as:

> *"…seaweed of any species that is unattached and cast ashore".*

3 'New Zealand fisheries waters' is defined in the Act as:

a) *all waters in the exclusive economic zone*

b) *all waters of the territorial sea of New Zealand*

c) *all internal waters of New Zealand*

d) *all other fresh or estuarine waters within New Zealand where fish, aquatic life, or seaweed that are indigenous to or acclimitised includes marine, estuarine, and freshwater waters.*

4 The scope of these definitions is broader than might usually be considered under the term 'seaweed' and includes not only the marine macro-algae that might be expected but also sea-grasses along with algae in the freshwater environment. Note that vascular aquatic plants, such as watercress, are not included in this definition. In addition, freshwater or marine algae, such as *Undaria pinnatifida,* that are currently managed as unwanted organisms under the Biosecurity Act, are exempt from the requirement to hold a fishing permit under s 89 of the Fisheries Act. Therefore, the management of such species is effectively outside the ambit of the Fisheries Act.

5 Commercial access to seaweed has been constrained by various moratoria on permits. The most recent of these was implemented in 1992 and is provided for under the current Act via s 93. There are extant permits, issued prior to 1992, for the following seaweeds (free-floating or attached): *Macrocystis pyrifera* (2), *Durvillea antarctica* (1), *Gracilaria* spp (3), *Lessonia* spp (1), *Porphyra* spp (1), *Pterocladia lucida* (5).

6 Over time, these moratorium constraints have been relaxed for seaweed as the need to provide for utilisation has been addressed. Firstly, commercial use of beach-cast red[2] seaweed has been exempt from the requirement to hold a fishing permit since the 1980s (s 89(2)(f)).

7 Secondly, a provision of s 67Q permits has enabled bycatch of seaweed with the capture of spat mussels on Ninety Mile Beach. Associated with the mussel harvest has been an inevitable bycatch of proportionately larger volumes of various forms of

[1] The proposals contained in this paper relate to the harvest of 'wild' stocks of seaweed-only. The harvest of seaweed growing[1] on marine or land based farms is not included in this paper. The nature of authorisations required for the harvest and removal of such seaweed is considered as part of the existing and proposed aquaculture legislation.

[2] Class Rhodophyceae

seaweed; the majority of this harvest is believed to be free-floating seaweed and the remainder beach-cast.

8 Thirdly, special permits have been approved since 1991 allowing paua farmers to take beach-cast and free-floating seaweed for the sole purpose of feeding their paua.

9 Fourthly, beach-cast seaweed was removed from the permit moratorium in 2001 by amendment to the Act (s 91(4)). It is currently managed under the generic reporting code SEO. Regulations[3] were implemented to restrict the areas beach-cast seaweed could be taken. These regulations are due to be reviewed in the near future.

10 In the case of the Ninety Mile Beach fishery, the regulations currently prevent the harvest of beach-cast seaweed but the seaweed is taken as a necessary bycatch under s 67Q permits. From 1 October 2004, harvesting of juvenile mussels will be authorised under the QMS. At that time, seaweed will still be able to be taken as a necessary bycatch under s 89, or, if the permit moratorium is relaxed as intended[4], MFish will be able to issue fishing permits to authorise this bycatch of seaweed.

11 In all cases, the targeted harvest of seaweeds is limited, by regulation, to the method of hand-gathering.

12 Non-commercial access to seaweeds is unrestricted. There are no "recreational" daily limits set for seaweeds.

13 The apparent complexity of these regimes is due to the different level of sustainability risk associated with beach-cast and the other states of seaweed, and the relaxation of the moratorium environment in a piecemeal fashion over time. MFish considers the regimes lack integration and have the potential to cause unnecessary complication in their management and for the activities of commercial participants.

[3] The Fisheries (Beach-cast Seaweed Prohibition) Notice 2001
[4] Revision of the Fisheries Act 1996: Consultation Document. 9th September 2003

APPENDIX TWO – SPECIES BIOLOGY

Bladder Kelp – *Macrocystis pyrifera* – (KBB)

Species

1 *Macrocystis pyrifera* (L.) C.Agardh is a member of the kelp order Laminariales, and belongs to the family Lessoniaceae. This species is also found in south-eastern Tasmania, southern South America (to Peru on the west coast and to 50°S on the east coast), and in the northern hemisphere from California to Baja. The common name, 'bladder kelp', used by the Ministry of Fisheries, is not used in other parts of the range of this species and is not commonly applied in New Zealand as it causes confusion with other brown algal species possessing bladders.

Biological Summary

Distribution

2 *Macrocystis pyrifera* occurs in the southern North Island around Cook Strait (from Kapiti Island on the west coast to Castlepoint on the east coast), South, Stewart, Chatham, Bounty, Antipodes, Auckland and Campbell Islands (Adams 1994). The distribution is patchy and there is both seasonal and interannual variation in abundance (Hay 1990, Pirker *et al*. 2000).

3 *Macrocystis* frequently forms colonies or large populations in calm bays, harbours or in sheltered offshore waters. It can tolerate a wide range of water motion including areas where tidal currents reach 5-7 knots (Hay 1990). Smaller thalli can be found in shallow pools and channels and there are free-living populations known from Port Pegasus and Paterson Inlet on Stewart Island.

4 Devinny & Volse (1978) studied the impact of sediments on the development of *M. pyrifera* gametophytes and found that sediments interfered with the settlement of spores and the process of attaching to substrate, as well as negatively effecting sporelings that had already settled. In the presence of water motion, sediments had a scouring effect on sporelings and survivorship was reduced.

Reproduction

5 This species has a diplobiontic, hetermorphic life history in which the conspicuous sporophyte phase alternates with a microscopic, dioecious gametophyte phase. Sori are produced on basal sporophylls.

Age and growth

6 *Macrocystis* thalli are perennial and grow to 20 m in length. A number of studies of *Macrocystis* in New Zealand have examined growth characteristics (e.g. Rapson *et al*. 1942, Moore 1942, Kain 1982, Nyman *et al.* 1990, 1993; DeNys *et al.* 1990, 1991, Brown *et al.* 1997). For *M. pyrifera* the seasonal pattern of blade relative growth rate (RGR) in Otago Harbour varies between years. Blade RGR's during 1986-87 were

similar year-round except for summer when lower rates were recorded, leading Brown *et al.* (1997) to conclude that this pattern represented N-limited growth similar to that of *M. pyrifera* in California. However, ongoing work on a nearby *M. pyrifera* population indicates that between 1998-2000, blade RGR was light-limited during winter and N-limited from mid-summer, a pattern consistent with *M. pyrifera* from British Columbia, Canada (Wheeler and Srivastava 1984) and the Falkland Islands (van Tussenbrook 1989) (Hurd pers. comm.). The high inter and intra-annual variation seen in growth rates of *M. pyrifera* illustrate the importance of long-term (> 1-year) monitoring to gain a thorough understanding of seasonal patterns. Seasonal patterns of nitrogen-limited growth can be implied from the ratio of tissue carbon (C) and nitrogen (N) (C:N) with higher ratios indicating greater N-limitation. For the Order Laminariales, 10-15 indicates N-sufficiency, 16-20 indicates mild N-limitation while values of >25 indicate severe N-limitation For *Macrocystis pyrifera* from Otago Harbour, the maximum C:N ratio is rarely >20 indicating only mild N-limitation of growth in summer.

7 McCleneghan & Houk (1985) examined the impact of canopy removal on holdfast growth in *M. pyrifera* in California and concluded that kelp canopy removal reduces hapteral divisions thus slowing holdfast growth, an impact that was still apparent six weeks following harvest. However Barilotti *et al*. (1985) found no effects of harvesting on hapertal elongation and branching as well as on plant survivorship.

Relationship with other species

8 *Macrocystis* forests are characterised as being amongst the most productive marine communities in temperate waters. Schiel & Foster (1992) state " the high productivity and habitat complexity of these plants contribute to the formation of diverse communities with considerable ecological, aesthetic and economic value. Moreover, food and habitat are exported from kelp forests to associated communities such as sandy beaches and the deep sea."

9 Along the east coast of the South Island the major understorey species associated with *Macrocystis* forests are the brown algae *Ecklonia radiata* and *Carpophyllum flexuosum*, along with a rich fauna of sessile invertebrates (Pirker *et al.* 2000).

10 Small scale harvesting experiments carried out in Akaroa Harbour showed that "harvesting canopy biomass had no measurable effect on *Macrocystis* plants, and the dominant understorey species" (Pirker *et al*. 2000).

Biomass Estimates

11 Maximum biomass of *Macrocystis* occurs in the winter months (Cummack 1980, Pirker *et al.* 2000). Pirker *et al.* noted that marked differences can exist in the demography of *Macrocystis* at a spatial scale of only a few kilometres – and that beds decline and regenerate at different times. In the Akaroa Harbour sites they studied they concluded that no one forest is capable of supporting the removal of consistent amounts of canopy, although two harvests could be sustained per year – one in late spring/early summer just prior to frond senescence and then another cut in late autumn/early winter.

Recommended Fishstock Boundaries

12 Fishstock boundaries must take into account several key principles. Comments which can be made on *M.pyrifera* in these principles are very limited.

- Management areas should be based principally on the biological characteristics of the stock. Data from the Banks Peninsula area indicates that sustainable harvesting will require a local/population focus, given the inter-annual variations in population size and recruitment.
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).
- Where practicable, QMAs for species taken together in the same fisheries should be aligned.
- Where practical, the same QMAs should be set for different species.
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit.
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries.
- Subject to the principles noted above QMAs should be as large as possible.

Assessment and catch summary

Previous assessments

13 No previous assessments of commercial catch. Experimental harvest data present in Cummack (1980) and Pirker *et al*. (2000).

Catch History

Catch and landing by region

Seaweed Estimates Database: reported weight (kgs) by year and fishing area

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2										2000	
15										110	
17					11						
19	50										
22				1285	27,100	276,250	199,500	18,000			
24		25,700	42,300	8,100	139,460	77,699	113,300	102,200	306,600	74,500	80,500
26	250	60									
27					2270	3690	4245				
49	850	6000	6000	3900	0	140*	0	0	105	200	134
940					590	580	100	200	25	60	
Null					800						

14 Three different systems for numbering fishing areas have been used in the above table. As *Macrocystis* only grows south of Castlepoint in the Wairarapa coast it will not be found in area 002 on the far north east coast of the North Island. Area 19 is an oceanic fishing zone and includes no coastal area. Areas 49 and 940 cover essentially the same area, on the north west of Chatham Island.

Seaweed Landings Database: Reported green weight (kgs) by year and landing point

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
KBB1							80				
KBB2										70	
KBB3	218		0	1250*	136,610*	32,670,360*	7,165,500*	670,000*			
KBB4	850*	3500*	5500*	4000*	570*	706*	550*	600*	128*	220*	136
KBB5					1710	350					
KBB6										20*	
KBB7					12						
Null						3320	4345		2		

*predominantly U. The abbreviation 'U' stands for bait which is a puzzling category to be used in the context of kelp. (Some kelps are used as feed stock for herbivores such as paua.)
The quantities recorded for some areas/years are very large and do not relate clearly to the data in the Seaweed Estimates Database.

	Landing Point
KBB1	Raglan
KBB2	Emerald Pearls
KBB3	Hina Hina, Wainui,
KBB4	Whangamoe, Whanganui, Whangarei, Port Hutt
KBB5	Halfmoon Bay, Auckland Bay
KBB6	Whangamoe
KBB7	Te Awaiti
Null	Halfmoon Bay, Whangaroa

Catch by method

15 The Seaweed Estimates database shows 6 records of SN (target BUT, method SN and also target MOK, method SN). There are also records with GRA and KBL as the target species - although both of these are seaweeds they occupy entirely different habitats from *Macrocystis*.

16 The method D (dredge) was entered for three records, with the remaining ca. 770 records listing 'H' (hand).

General Issues

17 Pirker *et al.* (2000) concluded that sustainable harvest of *Macrocystis* is possible in New Zealand using similar strategies to those employed by the State of California for the *Macrocystis* beds there. They considered that a combination of aerial photography and *in situ* measurements provide an easy method for assessing canopy biomass. They caution, however, that high levels of annual variation in canopy biomass, within and between forests, necessitates the need for annual stock assessments at a population scale until a better understanding of variability is reached.

18 Pirker *et al.* provide detailed options for harvesting strategies for the Banks Peninsula sites studies. They also consider that harvesting of other *Macrocystis* forests should not be allowed before stock assessment surveys have been carried out.

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Lessonia – LES

Species

1 The seaweeds referred to under the group name *Lessonia* are placed in the family Lessoniaceae, order Laminariales. In New Zealand waters *Lessonia* is represented by 4 species: *L. adamsiae, L. brevifolia, L. tholiformis* and *L. variegata.*

Biological Summary

Distribution

2 The genus *Lessonia* is distributed on exposed rocky shores across 18º of latitude from Spirits Bay to Campbell Island. *Lessonia variegata* is the most widely distributed of the four species occurring on exposed coasts around the North and South Islands. It is much less common in northern New Zealand where it is restricted to rocky headlands (e.g. Cape Brett). Although this species is recorded from Stewart Island and Fiordland there is uncertainty about the identification of specimens from some populations in these regions (Adams 1994, Schiel & Hickford 2001).

3 *L. adamsiae* is restricted to the Snares Islands, *L. tholiformis* to the Chatham Islands, and *L. brevifolia* is found on the Bounty, Antipodes, Auckland and Campbell Islands.

Reproduction

4 *Lessonia* has a diplobiontic and heteromorphic life history. That is, the conspicuous kelp phase is the diploid stage and this alternates with a microscopic gametophyte phase. Very little is known about the details of fertility in the New Zealand species although it is thought that the sporophyte phase is winter fertile. (A FRST funded research project on *Lessonia variegata* is currently underway, examining aspects of population structure and productivity, and the timing of fertility.)

Age and growth

5 No data are available on the age of first reproductive maturity (of sporophytes), the reproductive output of individuals, or the longevity of sporophytes. There is also no information available on the responses of populations to removal of adults from the canopy either through harvesting or through storm impacts. It is also not known how removal of blades without removal of holdfasts influences growth and survival of the remaining thallus. The meristem in *Lessonia* spp. is located at the base of each blade immediately adjacent to the junction with the stipe. If the meristem is removed the stipe is not able to regenerate a new blade. If the distal end of the blade is removed the meristem is able to continue functioning.

Relationship with other species

6 Schiel and Hickford (2001) observed that *Lessonia variegata* dominates some exposed east coast and Fiordland sites but is not an overall habitat-former in the areas they studied. At the Chatham Islands, however, *L. tholiformis* dominates shallow coastal areas that on the mainland are generally occupied by *Ecklonia radiata.*

Biomass Estimates

A summary of studies reporting on the quantitative abundance of *Lessonia* spp. at various locations in New Zealand:

Reference	Location	Species/ assemblage	Measure of abundance	Factors considered
Choat & Schiel 1982	Three Kings Northeastern NZ (x4) Owhiro Bay, Wellington	*Lessonia variegata*	Density/m^2	Depth, site
Schiel *et al*. 1995	Chatham Islands	Lessonia tholiformis	% cover Density/m^2	Site, depth
Schiel & Hickford 2001	Kaikoura, Banks Peninsula	*Lessonia variegata*	% cover Density/m^2	Site, coast, depth
Schiel & Hickford 2001	Fiordland	*Lessonia* spp.	% cover Density/m^2	Site, depth
Schiel & Hickford 2001	Chatham Islands	Lessonia tholiformis	% cover Density/m^2	Site, depth

Recommended Fishstock Boundaries

7 Fishstock boundaries must take into account several key principles.

- Management areas should be based principally on the biological characteristics of the stock. *Lessonia* spp. are very locally distributed on exposed rocky shores. Although these species are known to have a biphasic life history it is not known how the species disperse and which phase is most significant for the dispersal and/or recruitment within populations. There are no data available on the longevity of the sporophyte phase or on the length of survival of the gametophytes.
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).
- Where practicable, QMAs for species taken together in the same fisheries should be aligned.
- Where practical, the same QMAs should be set for different species.
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit. There is a single island-endemic species on the Chatham Islands, *L. tholiformis.*
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries
- Subject to the principles noted above QMAs should be as large as possible.

Assessment and catch summary

Previous assessments

8 No previous assessments have been made for any of the species.

Catch history and landing by region

Seaweed Estimates Database: Reported harvest in kgs.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
11													398
12									200				
14											20		
15				330	540	920	1940	2560	1990	1560	1500	1536	2970
18									40				
27							2270	3250	2140				
913	510	365	120										
null							210						
Totals	**510**	**365**	**120**	**330**	**540**	**920**	**4420**	**5810**	**4370**	**1560**	**1520**	**1536**	**3368**

These data exclude 26 records based on method anomalies.

Seaweed Landings Database: Reported harvest in kgs.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
LES1			131				352			488
LES2						29			217	2908
LES5			9	1950	380					
LES7	36									
Null					2920	2340				
Totals	**36**	**0**	**140**	**1950**	**3300**	**2369**	**352**	**0**	**217**	**3396**

*ES1: Auckland, Tauranga, Cape Runaway
LES2: Cape Runaway, Te Awhiti, Te Awaite, Emerald Pearls, Iron Pot
LES5: Halfmoon Bay, Riverton
LES7: Havelock
Null: Halfmoon Bay

Catch by method

9 Records for BT, RLP, BPT have been excluded as these methods are unlikely for the collection of *Lessonia* and in each case the target species listed was either a fish species (e.g. RCO, GUR, FLA) or in the case of RLP was CRA (rock lobster). All other records listed 'H' (hand) as method of collection.

General Issues

10 *Lessonia* spp. grow on exposed coasts and are predominantly subtidal. Because of the patchy distribution of these species there is potential for over-harvest and resource damage, unless a locally focused management regime is in place.

11 Management of *Lessonia* as a single stock (i.e. *L. variegata*) is possible around mainland New Zealand. Management at a population level in the short-term would be the most effective approach to decisions on resource access and quantities to be harvested, as there is extremely limited information on the biology or ecology of any species of *Lessonia*. If intensive removal of attached *Lessonia* thalli is undertaken it would be important to know about the impacts of harvesting on survival of individuals (if regrowth is the intention) or on the capacity for recruitment. This would require quantitative and seasonal field observations on biomass, productivity, distribution, reproduction and a recognition that these may differ in different regions within New Zealand

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BULL KELP – *Durvillaea* spp. – (KBL)

Species

1 Seaweeds referred to under the group name of *Durvillaea* belong to the family Durvilleaceae placed in the order Fucales. There are four species found in New Zealand waters; three are described and one is undescribed

Biological Summary

Distribution

2 All species except *D. antarctica* are restricted to New Zealand waters: *D. antarctica* has a south circumpolar distribution and is also known from southern Chile and Argentina, Falkland, South Georgia, Gough, Crozet, Heard, Macquarie Islands.

3 *D. antarctica – D. antarctica* is the most commonly found species in New Zealand, occurring from the Three Kings Islands south to the subantarctic islands. It is found only on the most exposed headlands in the northern North Island, becoming more common towards Cook Strait, and is present on exposed shores in the South, Chatham, Stewart, Snares, Bounty, Antipodes, Auckland, and Campbell Islands. This species is confined to the low intertidal zone. It is the largest species in the genus with an unbranched stipe and blades which can grow to 10m in length. The blades float because there are gas-filled air sacs within the plant in a honeycomb-like network

4 *D. chathamensis – D. chathamensis* is restricted to the Chatham Islands where it is found on the low intertidal shore at a slightly lower level than *D. antarctica*. Although superficially similar to *D. antarctica,* this species lacks the buoyant honeycomb tissue and has thinner blades with sinuous margins. As well as being shorter than *D. antarctica,* it does not have branched stipes as found in *D. willana.*

5 *D. willana – D. willana* is restricted to the South and Stewart Islands and does not extend into the subantarctic, or to the Chatham archipelago. It grows in the upper subtidal zone at around 1-2 m depth. The thalli are shorter with longer and thicker stipes than *D. antarctica* and have side branches growing out of the main stipe. The blades grow to ca. 5m in length and the thalli are not buoyant. *D. willana* can co-occur with *D. antarctica*.

6 The undescribed species is known solely from the Antipodes Islands where it forms dense subtidal forests from the upper subtidal zone through to depths of 10-15m. This species grows to 5m with a long stipe (to 1m), no honeycomb tissue, and with marginal, stipitate lateral blades.

7 *Durvillaea* spp. have the highest alginate contents of any seaweed (South 1979; South and Hay 1979; Hay and South 1979; Kelly and Brown 2000).

Reproduction

8 *Durvillaea* spp. have direct life histories with diploid dioecious thalli, that is, separate female and male thalli, producing eggs and sperm. In New Zealand reproduction is

from late autumn to early spring (April to September) with peak fertility in June-July (Hay 1994).

Age and growth

9 Large *D. antarctica* thalli may be 10 years old but more typically are 5-8 years. The life span of *D. willana* is longer; although the rigid stipe of this species is more vulnerable to snapping in severe storms, the holdfast of this species is not affected by burrowing animals as occurs in *D. antarctica.*

10 Hay (1994) summarises information available on growth rates in *Durvillaea.* Individual growth rates of *D. antarctica* and *D. willana* are highly variable. There is an inverse relationship between relative growth and plant size. In winter months tissue may erode more rapidly than it is produced. Growth rates for *D. antarctica* are fastest during late spring and summer, that is, after the reproductive period

Relationship with other species

11 At exposed sites in all regions *Durvillaea* spp. are the dominant algae of the immediate subtidal zone (Schiel & Hickford 2001). Schiel & Hickford examined the interactions of species at three spatial scales in the Chatham Islands, including *Durvillaea* spp. They recorded a positive correlation between *Haliotis iris* adults and *Durvillaea* spp.

12 Harvest trials of *Durvillaea* spp. revealed that in order to allow recruitment of new thalli attached thalli should only be harvested in winter during the fertile period. Harvests outside this time resulted in many competing species replacing *Durvillaea* spp. and the *Durvillaea* populations did not recover or return to pre-harvest biomass for some years (Hay & South 1979). These harvest experiments also showed that the whole thalli, including holdfasts, need to be removed as the holdfasts take a considerable time to rot and the presence of the dead holdfasts prevents resettlement of new *Durvillaea* thalli.

Biomass estimates

13 A summary of studies reporting on the quantitative abundance of *D. antarctica* at various locations in New Zealand is given below:

Reference	Location	Species/assemblage	Measure of abundance	Factors considered
Hay 1994	Various	Durvillaea antarctica	Density/m^2	Wave force
Hay & South 1979	Kaikoura, Otago	Durvillaea antarctica	Density/m^2	Time, clearance
Paine 1971	Northwestern NZ	Durvillaea antarctica	Proportion cover	Stichaster removal
South & Hay 1979	Auckland, Kaikoura (x3), Westland, Otago, Stewart island	Durvillaea antarctica	Density/m^2	Site, wave action

Recommended Fishstock Boundaries

14 Fishstock boundaries must take into account several key principles.

- Management areas should be based principally on the biological characteristics of the stock. *Durvillaea* spp. are located only on the most wave exposed headlands and coastal areas. The limited fertile period in which harvesting should occur and the patchy distribution of populations suggest that management at local scales will be required
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).
- Where practicable, QMAs for species taken together in the same fisheries should be aligned.
- Where practical, the same QMAs should be set for different species. Different species of *Durvillaea* have different geographical distributions and ecological distributions and these will need to be considered in setting of QMAs
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit.
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries.
- Subject to the principles noted above QMAs should be as large as possible. N/A

Assessment and catch summary

Previous assessments

15 Hay (1994) presents some partial data from harvest trials carried out in the 1970s on the east coast of the South Island. Between May 1971 and November 1973 approximately 75 T of dried *Durvillaea* was harvested with a maximum monthly harvest of 15 T.

Catch history and landing by region

Seaweed Estimates Database: Reported weight (kgs) by year and fishing area

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
14	70										
15		1040	3441	3271	4580	5220	7000	6200	6340	5165	3500
17		5									
19		50									
22			10	1285	3150	40100	55500	5000			
26	250	100									
913	625										
totals	**945**	**1195**	**3451**	**4556**	**7730**	**45320**	**62500**	**11200**	**6340**	**5165**	**3500**

There are some entries which register GRA (*Gracilaria*) as the target species and KBL as the species harvested. This seems most unlikely as these algae grow in entirely different habitats.

Seaweed Landings Database: reported green weight (kgs) by year and landing point

year	KBL2	KBL3	KBL7	NULL	green wt (kgs)	comments
1992		189			189	L
1993		0	6		6	L
1994		0			0	U
1995		300			300	all 'U'
1996		2900			2900	all 'U'
1997		1,599,100		100	1,599,100	all 'U'
1998		658,000			658,000	all 'U'
1999		60,000			60,000	all 'U'
2000					0	
2001	250				250	L
2002	3441				3441	L

The abbreviation 'U' stands for bait which is a puzzling category to be used in the context of kelp. (Some kelps are used as feed stock for herbivores such as paua.) These data are difficult to reconcile with the Seaweeds Estimates data with respect to quantity harvested. The quantities appear to be very large, particularly in years 1997-1999.

Catch and landing by region

16 The majority of the harvest recorded in the Seaweed Estimates Database comes from the Wairarapa coastline and from south of Banks Peninsula and south Otago. The fishing area 19 has no coastline so this record is viewed as anomalous. In the Seaweed Landings database the landing points are as follows:

- KBL2: Te Awhiti, Te Awaite, Emerald Pearls
- KBL3: Hina Hina, Wainui
- KBL7: Ward Beach
- Null – Wainui

Catch by method

17 In the Seaweed Estimates Database for Bull Kelp there are 527 entries all of which give H (hand) except one (MOK, SN, KBL = 5 kg)

General Issues

18 Hay & South (1979) studied the impacts of harvesting in different seasons on the recruitment and recolonisation of *D. antarctica* and *D. willana* populations. They concluded that year round harvesting would result in depletion of the resource as season is critically important to recolonisation. They recommended that harvesting should only occur during the winter. This is the fertile period for *Durvillaea* spp. (May to September for *D. antarctica* and June to October for *D. willana*), and thus is when zygotes are being produced and able to settle and re-establish.

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Porphyra – (PRP)

Species

1 The seaweeds referred to under the group name *Porphyra* are found throughout the world from polar to tropical seas, with in excess of 130 species described. For many years the name *Porphyra columbina* was applied to all *Porphyra* collected from rocky shores around New Zealand. However it has been clear for some time that this does not adequately represent the diversity present here (Nelson & Conroy 1989, Adams 1994).

2 Current research work indicates that New Zealand is likely to be one of the richest regions in the world in terms of *Porphyra* species diversity. At present 35 species are able to be distinguished by unique 18S rDNA sequences; new species have been discovered in each of the past 15 years. Four new endemic species have been described for New Zealand (Nelson *et al.* 2001) and the occurrence of the widespread *P. suborbiculata* confirmed (Broom *et al.* 2002). Three obligate epiphytic species endemic to New Zealand and previously placed in *Porphyra* have been transferred to new genera in a different order (Nelson *et al*. 2003)

Biological Summary

Distribution

3 Some of the species are widespread, occurring through the North and South Islands, and extending to the Chatham Islands and Stewart Island, whereas others have highly restricted distributions. Some taxa are currently known from a single locality. Although in New Zealand *Porphyra* spp. have been traditionally regarded as growing only in the upper intertidal zone, in fact the ecological niches occupied by particular species vary widely, for example:

4 *P. coleana* is always found at the highest levels of the intertidal zone and higher on the shore than all other species. It is only present on rocky reef habitats from North Cape to the northern South Island and on the Chatham Islands, and can be found from late summer through to spring (February to November).

5 *P. viridiidentata* is found in the mid-low intertidal zone on rock, sometimes partially buried in sand. It reaches the northern shore of Cook Strait and is also found on the east coast of the South Island. It is highly seasonal in its growth, occurring from mid-winter to spring (July to October).

Reproduction

6 *Porphyra* species possess a diplobiontic, heteromorphic life history with a number of accessory reproductive modes. That is, the bladed phase (haploid stage) alternates with a microscopic (diploid) phase. The microscopic phases is also referred to as the conchocelis stage as it is known to live within the lamellae of mollusc shells and rocks. Species of *Porphyra* are considered to display some of the most complex life histories known in the algae. In addition to sexual reproduction and alternation of generations, particular species may have a wide array of accessory reproductive

modes including archeospores, agamospores, neutral sporangia (on both conchocelis and blade phase), and endospores.

Age and growth

7 Data on age and growth are species specific and there are few data available. Although a study on growth and reproduction of *Porphyra* was carried out at three sites in southern New Zealand (Brown et al. 1990), it is now recognised that multiple species occur at each of these sites and thus the data do not contribute to an understanding of growth and age for any particular species.

Relationship with other species

8 Not possible to generalise about ca. 35 species with very different geographical and ecological distributions.

Biomass Estimates

9 A study was carried out in the Kaikoura area in the 1980s to examine harvest method and timing, and the impact of previous harvesting on yield and regeneration (Nelson & Conroy 1989, Nelson *et al.* 1990). The method of harvest was found to have a major effect on the extent of regeneration: where basal tissue was left, thalli were able to be harvested again in two months whereas complete removal of thalli saw very little new recruitment and growth.

10 This study did not address inter-annual variation in population size or the impact of harvesting on the growth in subsequent seasons. It did show, however, that if harvesting is carried out in such a way as to leave basal material, regeneration occurs rapidly and thus, multiple harvests can occur.

11 Previous examinations of the populations at Kaikoura by MAF staff, and discussions with the permit holder during the 1980s suggested that there are significant inter-annual variations in the biomass and local distribution of *Porphyra* spp. at Kaikoura. This variability has since been observed around the country with a range of species.

Recommended Fishstock Boundaries

12 Fishstock boundaries must take into account several key principles.

- Management areas should be based principally on the biological characteristics of the stock. Management areas should be small given the local nature of the resource and the fact that a number of species with very different life history characteristics may live adjacent to one another at a single site.
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).
- Where practicable, QMAs for species taken together in the same fisheries should be aligned.
- Where practical, the same QMAs should be set for different species. N/A
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit.

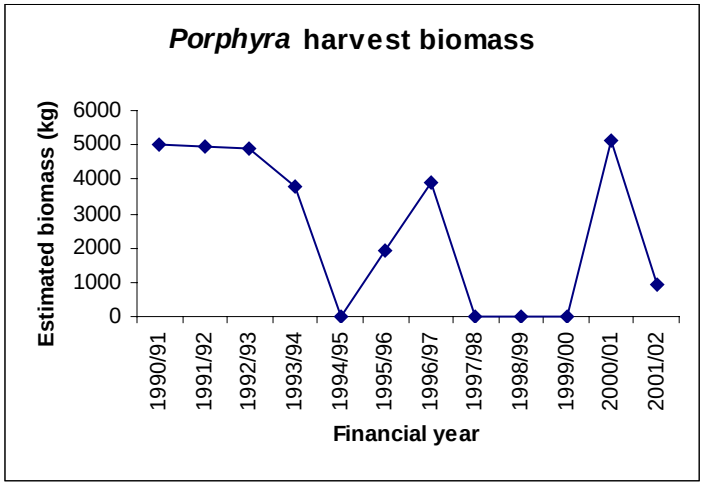
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries. N/A
- Subject to the principles noted above QMAs should be as large as possible. N/A

Assessment and catch summary

Previous assessments

13 No published data available although there may be data in internal Fisheries reports from the early 1980s when the Kaikoura resource was first examined prior to a permit being issued.

Catch History



Catch and landing by region

14 All recorded harvest is from the Kaikoura region (area 18).

Catch by method

15 All recorded harvest is by hand picking

General Issues

16 Karengo is listed as a taonga in the Ngai Tahu Deed of Settlement. The harvest of *Porphyra* spp. around Kaikoura has been operating sustainably for more than 15 years. It is important that the management regime for this resource recognises the regional characteristics (for example in the species present, the timing of growth and fertility with temperature) as well as site specific features. Seasonal and inter-annual variation in population size and growth mean that caution is required when setting harvest limits.

17 Management of a genus as a single stock is unlikely to succeed, given that the genus includes up to 35 species. There are no data available which would provide a biogeographic or species-defined basis for decision making: there is no information

about standing stock, productivity, seasonality of growth for any species or group of species.

18 Management at a population level is limited also by the absence of data, but in the short-term would be the most effective approach to decisions on resource access and quantities to be harvested. This would require quantitative field observations on biomass, productivity, distribution, and seasonality.

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Gracilaria spp. - (GRA)

Species

1 The seaweeds referred to under the group name *Gracilaria,* are included in a red algal genus that belongs to the family Gracilariaceae, order Gracilariales. There are 6 species currently recognised in this genus in New Zealand and three of these are undescribed. The most well known species are *G. chilensis* (previously known as *G. sordida*), *G. secundata* and *G. truncata* (Adams 1994). These species differ significantly morphologically and occupy very different habitats. Both *G. chilensis* and *G. secundata* are species that are terete (round in cross section) whereas *G. truncata* has a flattened thallus.

2 The three undescribed species consist of 2 cryptic species that strongly resemble other members of the flora and one species that is restricted to the subantarctic islands. One of the cryptic species is present in large quantities in the Manukau Harbour. The application of molecular sequencing techniques has enabled this species to be distinguished from *G. chilensis*, (Candia *et al*. 1999) and the difference in these species is also reflected in their chemistry (Wilcox *et al.* 2001).

Biological Summary

Distribution

3 Species of *Gracilaria* are found from northern New Zealand through to the subanatarctic islands. *Gracilaria* has also been collected from the Kermadec Islands but as this was sterile material it has not been able to be identified to species.

4 *Gracilaria chilensis* is found in sheltered sites, frequently in harbours and estuaries and often in areas with muddy sands. It grows attached to shell fragments as well as on living cockles, cobbles and rocks, in the low intertidal zone through to the upper subtidal (to ca. 1-2 m). Occasionally it grows in free-living masses. It is found from the northern North Island through to Stewart Island and also in the Chatham Islands.

5 *Gracilaria secundata* is found on open exposed coasts attached to rock in the low intertidal zone extending to considerable depth subtidally. It often grows on rocks that are periodically buried by sand. It is found from the southern North Island through to Stewart Island and the Chatham Islands and has also been found on the Auckland Islands.

6 *Gracilaria truncata* is found both in harbours and on the open coast from the northern North Island through to Stewart Island. It grows in the low intertidal and also subtidally. It can be readily mistaken for several other unrelated macroalgae.

7 One of the cryptic species is likely to be of commercial interest. It is indistinguishable in the field from *G. chilensis* and is so far only able to be certainly identified using molecular sequencing tools. It is growing in abundance in the Manukau Harbour and has also been found in the Orakei Basin, Waitemata Harbour. Further research is required to understand the distribution of this species and to determine morphological features to distinguish this species from *G. chilensis*. Given the unusual distribution

of this species, restricted to 2 harbour areas that are highly modified, the possibility that species is not native needs to be considered.

Reproduction

8 Members of the genus *Gracilaria* have an alternation of isomorphic tetrasporophyte and dioecious gametophyte generations. That is, the thalli have the same morphology in all stages of the life history. The carposporophyte stage is conspicuous with large cystocarps formed on female gametophytes.

Age and growth

9 It is not possible to generalise about species specific characteristics. Laing *et al*. (1989) grew *G. chilensis* in culture, examining the influence of temperature, light and nitrogen on growth. Laboratory experiments on *G. chilensis* and *G. truncata* gave relative growth rates of 5-8% per day for *G. chilensis* and 2-4 % per day for *G. truncata* for 5 weeks in culture, with *G. truncata* becoming necrotic after this point (Pickering *et al.* 1993). Growth is faster for *G. chilensis* in summer and late autumn, increasing with temperature from 10-25ºC (Terzaghi *et al*. 1987).

Relationship with other species

10 As the widely distributed *Gracilaria* species in New Zealand occupy different habitats their relationships with other species are species specific. There are few data available about the ecology of these species in relation to other species. There are some autecological data for *G. chilensis* in unpublished theses and in Nelson (1989) amd Pickering *et al*. (1990). It is not known what interactions occur between *G. chilensis* and the co-occurring undescribed species in the Manukau Harbour, and whether one species is displacing the other.

Biomass Estimates

11 As part of autecological studies, Nelson (1989) and Pickering *et al*. (1990) presented data on the biomass of *G. chilensis* from the Wellington region and Invercargill respectively. A series of reports produced in 1980s on the potential for aquaculture of *Gracilaria* (Nelson *et al.* 1986, Terzaghi *et al*. 1987) estimated a production rate of ca. 30 T/hectare of *G. chilensis*. These estimates in part were based on data from the studies carried out at the Auckland Regional Authority Manukau Sewage Purification Works. Adjacent to this area there were very extensive beds of *Gracilaria*, which were considered to be a result of the high nutrient levels in the effluent from the Works, and during the 1980s there were various attempts to harvest the *Gracilaria* in these beds. In the past two years the oxidation ponds in the Manukau have been dismantled and the area where the *Gracilaria* beds once were found is now substantially physically altered. There are still extensive beds of *Gracilaria* in other parts of the Manukau Harbour, although the relative proportions of the two terete *Gracilaria* species is unknown.

Recommended Fishstock Boundaries

12 Fishstock boundaries must take into account several key principles in the 1996 Fisheries Act which promote sustainability.

- Management areas should be based principally on the biological characteristics of the stock. This would require a population based approach to be applied as the populations are patchy in distribution.
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).
- Where practicable, QMAs for species taken together in the same fisheries should be aligned.
- Where practical, the same QMAs should be set for different species.
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit. The major area where *G. chilensis* grows on the Chatham Islands is in the Te Whanga Lagoon; this area is managed by the local authority.
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries.
- Subject to the principles noted above QMAs should be as large as possible.

Assessment and catch summary

Previous assessments

13 No data are available for previous assessments based on catch history.

Catch history and landing by region

Seaweeds Landings Database: green weight (kgs) by year

stock	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	kgs
GRA1		128	85				97	298	396		3				**1007**
GRA2	10	47					3				60		273		**393**
GRA3		6		187					517		321				**1031**
GRA4						175	700	67							**942**
GRA5	7	1	0	210	32			195	38					4	**487**
GRA6							911	400	330		142				**1783**
GRA7			1				12	29							**42**
GRA8					487	19	554	472	915				714		**3161**
GRA9												10			**10**
	17	**182**	**86**	**397**	**519**	**194**	**2277**	**1461**	**2196**	**0**	**526**	**10**	**987**	**0**	

Quantities vary widely from year to year:

Landing points:

stock	destinations	
GRA1	L	Northland west & east coasts
GRA2	L	Northland and Great Barrier
GRA3	L	Gisborne to Port Chalmers
GRA4	U (875), L (67)	Chatham Islands (U), Wellington (L)
GRA5	L, F	Port Underwood to Akaroa
GRA6	L	Chatham Islands
GRA7	L	Otago
GRA8	L	Bluff, Stewart Island, Milford Sound, Opunake
GRA9	L	Kawhia

Seaweed Estimates Database: weight (kgs) by year and fishing area

Data from this database also present a picture of fluctuating catch levels. The following data are excluded from the summary table:

- entries which listed methods BLL, BS, BT as these all seemed most unlikely methods for species that are found largely in intertidal and upper subtidal zones
- entries where target was CRA and method RLP as it appeared very likely that the landed species GRA was incorrectly entered
- 2 records with target SNA and GMU using method SN.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
14			70								
15				1065	730	660	1160	460	840	760	660
19			70								
20						22,500					
24				18,700							
26			250								
49					175	1484		30			
51										460	105
913	400	1226	912								
940						124	220	20			
943						131	129				
	400	**1226**	**1302**	**19,765**[1]	**905**	**24,899**[2]	**1509**	**510**	**840**	**1220**	**765**

[1]includes 6 records of between 2,500 and 3,500 kg
[2]includes 2 records of 10,500 and 12,000 kg.

14 A significant quantity of GRA was landed (in areas 24 and 49, with 13,875 kg in years 1993-1995) where the target was given as KBB. It seems highly improbable that *Gracilaria* would be harvested when targeting species of *Durvillaea*.

15 Area 19 has no coastline so the single entry included here is an unlikely record.

Catch by method

16 Seven codes have been assigned in the database for method of harvest - BLL (bottom long lining), BS (beach seining), BT (bottom trawl), SN (set netting), RLP (rock lobster potting), DI (diving) and H (hand). The first five of these appear unlikely as methods of harvest/collection.

17 Entries in both databases give "H" and "DI" as the predominant catch methods.

General Issues

18 Management of this genus as a single stock is unlikely to succeed, given that *Gracilari*a in mainland New Zealand includes at least 4 species with commercial potential, occupying different habitats. In the past *G. chilensis* has been regarded as the species with the most significant commercial potential, both as an agarophyte and as a species that can be used to feed farmed paua. There is a major problem, however, resulting from the recent discovery of the cryptic species in the Manukau Harbour, as it apparently grows alongside *G. chilensis*, occupying a similar ecological niche. There are no data available on how, or if, the productivity and growth of these species differ. Although a number of studies have been carried out in the Manukau, the stocks there were treated as a single species and thus there must be questions about the reliability of these data.

19 At least in the case of the harbour and estuary populations of *Gracilaria*, gene flow or recruitment between populations is most unlikely (e.g. *G. chilensis, G. truncata* and the Manukau Harbour cryptic species). Because of the patchy distribution of all species of *Gracilaria* there is potential for over-harvest and resource damage unless a locally focused management regime is in place.

20 Management at a population level is limited by the absence of data for most sites, but in the short-term would be the most effective approach on which to base decisions on resource access and quantities to be harvested. This would require quantitative field observations on biomass, productivity, distribution, and seasonality. Although the polysaccharide agar does not appear to differ between life history phases, it is not known how each phase contributes to the reproduction/population stability. Research is required to determine if harvesting regimes and management approaches need to take this into account.

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Pterocladia - (PTE)

Species

1 The seaweeds grouped under the name *Pterocladia* include two species in different genera, *Pterocladia lucida* and *Pterocladiella capillacea* (previously *Pterocladia capillacea*), both of which belong to the red algal family Gelidiaceae in the order Gelidiales. Members of this order of red algae contain the cell wall polysaccharide agar.

2 *Pterocladia lucida* is a richly branched robust alga reaching 20-50 cm in height. Amongst individuals there is a great deal of variation in the appearance of thalli, largely owing to variation in the degree of branching and the width of axes, to the extent that at various stages a number of varieties have been described. It is generally accepted that these are environmental or strain variants but are not worth recognition at a higher taxonomic rank.

3 *Pterocladiella capillacea* grows to ca. 10 cm in height in tufts, with individual thalli frequently very densely branched. It has much finer axes than *P. lucida.*

4 Approximately 95% of the harvest is reported to consist of *Pterocladia lucida* with the remaining 5% consisting of *Pterocladiella capillacea* (Luxton & Courtney 1987).

Biological Summary

Distribution

5 *Pterocladia lucida* is known from parts of Australia and New Zealand. In New Zealand it occurs from the Three Kings Islands, North Island, the South Island from NW Nelson on the west coast to the Kaikoura peninsula on the east coast, and also on the Chatham Islands. It is primarily a subtidal reef species and is found on open, exposed coasts. (Adams 1994)

6 In New Zealand *Pterocladiella capillacea* is found from the Kermadec Islands, Three King Islands, North Island to the northern South Island, extending to Fiordland on the west coast, and in the Chatham Islands. Typically this species is found in the low intertidal zone, occasionally extending into the upper subtidal zone. It is found most commonly on open exposed coasts, in pools and channels where water is retained at low tide. (Adams 1994)

7 Dr Lucy Moore, working for Botany Division DSIR, was involved in the early development of the NZ agar industry and responsible for locating appropriate resources for harvest. Moore (1946) discussed the distribution of *Pterocladia lucida* and *Pterocladiella capillacea* at a number of localities in the North Island and the harvest obtained from 1942-1945.

Reproduction

8 Both species have isomorphic monoecious gametophyte and tetrasporophyte phases. That is, female and male reproductive structures are found on different individuals, and these gametophytes look the same as the phase that produces tetrasporangia.

9 *P. lucida* is frequently found to be fertile whereas reproductive structures are rarely found on *P. capillacea*.

Age and growth

10 Research to date has focused on *Pterocladia lucida*. Gerring *et al.* (2001) found that thalli harvested in summer either by plucking or by cutting recovered to their initial biomass within 12 months, whereas when harvested in winter, the cut and the plucked thalli remained smaller than the control thalli and did not recover biomass within a year. They concluded that sustainable harvest of the resource was possible if the removal occurred in summer – but cautioned that this conclusion needed to be tested at larger physical scales, over longer time periods and at other sites.

Relationship with other species

11 Gerring *et al*. (2001) examined the effects of harvesting *Pterocladia lucida* on species that co-occur. There was no evidence to suggest that either plucking or cutting of *P. lucida* altered the densities of the large brown alga *Carpophyllum maschalocarpum,* or the invertebrates kina or *Cookia sulcata* occurring within the experimental sites. However, they caution that "the lack of effect may have been due to the small scale of the harvesting experiments, and if large scale harvesting was to occur, then a further study investigating these ecological impacts is recommended".

12 No information is available for *P. capillacea.*

Biomass Estimates

13 There have been two research studies on the assessment of stocks of *Pterocladia lucida*. McCormick (1990) compared a variety of survey techniques at sites in the Leigh Marine Reserve in the north eastern North Island and at Ngawihi on the south Wairarapa coast. He concluded that a semi-systematic design with replicate quadrats at fixed depths with regularly spaced sites was the preferred approach as it was less time consuming than other methods tried and allowed statistical comparisons of biomass between depths, sample sites and geographic locations as well as an acceptable ability to estimate standing crop. McCormick found that the biomass of *P. lucida* at Leigh was highly variable along and down the reef. Much of the variation was explained by differences between depths although there was even greater variation between quadrats. Thus although there was a general trend with depth there was very significant patchiness in distribution. This contrasts with the pattern of distribution found at Ngawihi where much of the variability in *P. lucida* biomass was attributable to differences between quadrats and there was no depth trend found in the biomass data. McCormick considered that these differences were at least in part attributable to the differing reef topography with steeply sloping short reef structure at Leigh and long and gradually sloping reefs on the Wairarapa coast at Ngawihi. These differences in topography will effect the influence of wave exposure and light penetration, two key environmental factors influencing macroalgal distribution.

14 Gerring *et al*. (2001) assessed biomass of *P. lucida* at Waihau Bay in the eastern Bay of Plenty using two approaches and obtained estimates for both summer-autumn and for winter.

15 Although various figures have been published describing the *Pterocladia* resources these estimates are very locally focused and somewhat difficult to compare. For example, Luxton & Courtney (1987) stated 'relatively small areas have sustainable yields in excess of 10 t dry wt.yr^{-1}'. McCormick (1990) gave a standing crop estimate for a 3 km stretch of coast in north eastern North Island as between 25,336 kg ± 9159 and 32,980 kg ± 5081 kg depending on which method was used for surveying the populations. Gerring *et al*. (2001) recorded 146-200 wet weight t in a 436,556 m^2 area sampled in summer autumn and a winter biomass of 119-121 wet weight t for the same area. They converted this to an estimated figure of 173 t wet weight over the 4.4 km of coastline studied. McCormick (1990) calculated a wet weight to dry weight regression equation (dry weight = 0.116 + 0.316 x wet weight) and thus at the Waihau Bay study site there was ca. 55 t dry weight of *P. lucida.*

16 Gerring *et al*. (2001) cautioned that there is likely to be significant interannual variability in the abundance of *P. lucida* and that this limits the extent to which results from a specific site/time can be generalised to other places and times.

17 No information is available for *P. capillacea.*

Recommended Fishstock Boundaries

18 Fishstock boundaries must take into account several principles.

- Management areas should be based principally on the biological characteristics of the stock. This would need to focus on the site-attached nature of the resource and thus need to use small-scale management. Although there are no specific data available it is highly likely that the productivity of populations in northern New Zealand (Ahipara, Bay of Islands, Bay of Plenty) will differ from those in the southern Wairarapa/Cook Strait or Kaikoura.
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues). This fishery has been operating for 60 years and distinct regional characteristics are apparent in the methods of collection that predominate in particular places.
- Where practicable, QMAs for species taken together in the same fisheries should be aligned. N/A
- Where practical, the same QMAs should be set for different species. N/A
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit. Although both species occur around the Chatham Islands there is no historical or current harvest in this region.
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries.
- Subject to the principles noted above QMAs should be as large as possible. N/A

Assessment and catch summary

Previous assessments

19 Nelson (1986) summarised harvest statistics for the years 1982-1985 for the regions Wairarapa, Bay of Plenty, Ahipara, Bay of Islands, and Hokianga.

Catch History

Data on *Pterocladia* from the databases:

year	seaweed landings (green weight kgs)	seaweed estimates (weight kgs)
1991	292	1473
1992	8616	34553
1993	5874	28345
1994	7693	36561
1995	7529	33643
1996	1742	11397
1997	1978	7283
1998	0	17
1999	0	0
2000	0	0
2001	0	55
2002	7	391

Catch and landing by region

Data from the "*Pterocladia*" seaweed landings database shows that the "*Pterocladia*" came from 4 stocks over the period 1991-2002 with the vast majority collected from PTE2:

stock	PTE1	PTE2	PTE3	PTE9
harvest total	2312	30451	175	793

20 Data from the "*Pterocladia*" seaweed estimates database has entries for harvest of "*Pterocladia*" from 12 fishing areas, with the majority of the harvest coming from the southern Wairarapa coastline. There is confusion in the use of the statistical codes as several different systems are being used. From these data it is not possible to interpret how codes 1-3 have been used. Area "1" must be referring to QMA1 harvest area given that area "1" is to the north east of the North Island and is not a coastal region and thus not an area where *Pterocladia* harvest is possible. Regions 2 and 3 could be QMA 2 and 3 or could be referring to regions around the northeastern North Island. The use of 14-16 refers to regions along the south east of the North Island as does "914" a rock lobster fishing return statistical area.

fishing area	total harvest (1991-2002)
1	870
2	164
3	7502
11	7
14	800
15	97727
16	37930
19	30
26	240
34	74
46	6095
914	2119

Catch by method

21 Five codes have been assigned in the database for method of harvest - BLL (bottom long lining), BSS (beach seining), D (dredging), DI (diving) and H (hand). The first three of appear unlikely as methods of harvest/collection.

22 The *Pterocladia* harvest was composed of ca. 69-75% drift or beach-cast weed and 25-31% picked attached thalli in the 1980s (Nelson 1986, Luxton & Courtney 1987). The proportions of the harvest that are drift or picked vary significantly in different regions. Schiel & Nelson (1990) reported that 96% of the harvest in the sheltered and warm waters of the Bay of Islands was from attached thalli whereas on the exposed coasts of the Wairarapa area 95% was harvested from shore cast thalli. Gerring *et al*. (2001) found only negligible quantities of beachcast *Pterocladia* during the two years of their study in the Waihau Bay area (Bay of Plenty).

23 Although recent reports (Gerring *et al*. 2001) suggest that only 15% of the total harvest is taken by diving, it is not possible to conclude that the remainder is drift. There are three collection methods that are not distinguished in the statistics collected:

- handpicking attached thalli from the shore,
- diving to hand-pick from deeper populations, and,
- collection of beachcast material.

24 From the seaweed estimates database it is not possible to distinguish whether drift or attached thalli were collected.

General Issues

25 Populations of *Pterocladia lucida* and *Pterocladiella capillacea* have been sustainably harvested for more than 60 years. Because of the patchy distribution of these species there is potential for over-harvest and resource damage in the areas where hand-picking predominates as the collection method, unless a locally focussed management regime is in place.

26 Management of these two species as a single stock is unlikely to succeed, given that they occupy different habitats, and relatively little is known about *P. capillacea* in New Zealand. Management at a population level is limited also by the absence of data, but in the short-term would be the most effective approach to decisions on resource access and quantities to be harvested. This would require quantitative field observations on biomass, productivity, distribution, and seasonality.

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Ecklonia radiata – (ECK)

Species

1 The brown kelp *Ecklonia radiata* belongs to the family Alariaceae, order Laminariales.

2 An endemic New Zealand species *Ecklonia brevipes* is considered by some authors to be distinct from *E. radiata* although there is the suggestion that it is a growth form, restricted to areas of low water movement and illumination (Adams 1994).

Biological Summary

Distribution

3 In New Zealand waters *Ecklonia radiata* is the ubiquitous kelp, found from the Three King Islands in the north (Adams & Nelson 1985) to Stewart Island in the south (Adams 1994). It is not found on the subantarctic islands nor on the Chatham Islands, although individuals have been found east of the South Island on the Mernoo Bank at 100 m (WELT, Te Papa). *Ecklonia radiata* is also found in southern Africa, in the cold water upwelling zones of Oman, western and southern Australia, Tasmania and on the east coast to northern New South Wales.

4 *Ecklonia radiata* grows subtidally on rocky shores from moderate shelter through to exposed coasts and from the low intertidal zone to depths greater than 25 m (Schiel & Nelson 1990). In the northern North Island *Ecklonia radiata* has a bimodal distribution forming stands around 5 m depth, sharing the 2-8 m depth with fucalean species, and often dominant at 10-20m depth except in sheltered waters (Choat & Schiel 1982, Schiel 1990). The echinoid dominated intermediate depth is rare south of East Cape (Schiel & Nelson 1990).

Reproduction

5 This species has a diplobiontic, hetermorphic life history in which the large conspicuous kelp phase (sporophyte) alternates with a microscopic, dioecious gametophyte phase. Sori are produced on basal sporophylls. The gametophyte phase of *Ecklonia radiata* is very much reduced relative to other members of the Laminariales (Jennings 1967, Novaczek 1984b).

6 The fertility of thalli and the appearance of recruits are seasonal. *Ecklonia* is winter fertile and in the north-eastern North Island shallow populations have sori from May to November (Novaczek 1984b) and recruits appear from September to late December (Schiel 1981). Schiel observed that recruitment in *Ecklonia* is temporally limited and closely linked to reproductive periodicity suggesting that the microscopic phase does not remain viable for very long. He also observed a spatial element to recruitment success, as canopy species are the ones most likely to recruit into cleared patches. Schiel (1981) found that in the north-eastern North Island, 75% of recruits of *Ecklonia radiata* occurred within 8 m distance from adult thalli.

Age and growth

7 Adult *Ecklonia* thalli can be large and as few as 20 adult thalli per m^2 may form a closed canopy (Trenery 1985). In north-eastern New Zealand thalli from depths 2-7 m have high lamina growth rates (5.4 +/- 0.4 cm per month) during December and January whereas at 15m depth in the same period growth rates were lower and differences between sites were apparent (Trenery 1985). Wave action at shallow sites reduces lamina length. In areas that have been harvested, recruitment, growth and survival were much greater than in control plots except at very shallow depths. High light intensity inhibits the growth of recruits and/or enables other algal species to take over the available space (Trenery 1985, Schiel 1988).

8 In southern New Zealand in Doubtful Sound Miller (pers.comm.) has recorded growth rates of 0.06-0.45 cm d^{-1}, with a temporal pattern of high growth rate from September to February, low rates from April through to June, with increases beginning again in August. Miller found significant inter-annual variation in the timing and amount of growth recorded. Low inorganic nitrogen concentrations in the seawater and C:N ratios indicate that in Doubtful Sound E. radiata is in N-limited year round. Density of individuals is also low in Fiordland with 2.5-10 thalli m^{-2} (Miller pers. comm.).

Relationship with other species

9 The importance of *Ecklonia radiata* to marine communities is well documented and the phenology of this species indicates that the ecological consequences of harvesting could be significant (Schiel 1988, Schiel & Nelson 1990 and authors therein). Jones (1984, 1988) showed that reef fishes such as wrasses and monocanthids recruit, some exclusively, among the fronds of *E. radiata* and feed exclusively on small invertebrates there. Choat & Ayling (1987) showed that the presence of *Ecklonia* beds affects the character of the fish fauna throughout northern New Zealand. Sea urchins do not recruit or survive well as juveniles in *Ecklonia* beds (Andrew & Choat 1985).

10 Interactions between *Ecklonia* and fucoid algae and the effects of canopy removal on recruitment have been studied by Schiel (1981, 1988). When *Ecklonia* canopy was removed in summer *Sargassum* and *Carpophyllum* species recruited first, although *Ecklonia* recruited 6-9 months later.

Biomass Estimates

11 Trenery (1985) observed that stipe length, stipe diameter and wet weight are highly correlated and that lamina length is independent of stipe length. Biomass, plant size and plant density vary with locality and depth, with the maximum biomass (3.6 +/- 0.2kg.m^{-2}) and plant density (15.6 +/- 0.5 m^{-2}) recorded by Trenery at 7 m depth. Mean thallus size was greatest at deepest sites.

12 Research on the standing stock and production of *Ecklonia radiata* has been carried out in Australia (e.g. Kirkman 1984).

A summary of studies reporting quantitative abundance of *Ecklonia radiata* at various locations in New Zealand.

Reference	Location	Measure of abundance	Factors considered
Andrew & Choat 1985	Leigh, northeastern NZ	density/m^2	Site
Andrew & MacDiarmid 1991	Leigh, northeastern NZ	density/m^2	Site
Babcock *et al*. 1999	northeastern NZ	density/m^2	Site, habitat, time
Choat & Schiel 1982	Three Kings northeastern NZ (x4) Owhiro Bay, Wellington	density/m^2	Depth, site
Davidson & Chadderton 1994	Nelson region	density/m^2	Site, substrate
Kotua-Dickson 1984	northeastern NZ	% cover, density/m^2	Depth, exposure, site
Novaczek 1984	northeastern NZ	density/m^2	Site, depth
Schiel 1982	northeastern NZ	density/m^2	Depth
Schiel & Hickford 2001	Kaikoura Banks Peninsula	% cover density/m^2	Site, coast, depth
Schiel & Hickford 2001	Fiordland	% cover, density/m^2	Site, depth
Shears & Babcock 2002	Northeastern NZ	% cover	Site, time, urchin removal

Recommended Fishstock Boundaries

13 Fishstock boundaries must take into account several key principles in the 1996 Fisheries Act which promote sustainability.

- Management areas should be based principally on the biological characteristics of the stock. Given the local distribution of spores/recruits, management should occur on a population basis.
- The stock boundaries should take into account the existing characteristics of the fishery (known fisheries, relevant fisheries management issues).
- Where practicable, QMAs for species taken together in the same fisheries should be aligned.
- Where practical, the same QMAs should be set for different species.
- A separate QMA should be set for the waters surrounding the Chatham Islands if the stock can be managed effectively as a unit. *Ecklonia* does not occur on the Chatham Islands.
- QMAs with new boundaries may be appropriate for species with populations whose distributions do not align with existing QMA boundaries.
- Subject to the principles noted above QMAs should be as large as possible.

Assessment and catch summary

Previous assessments

14 No data available.

Catch history and landing by region

Seaweed Estimates Database: weight (kgs) by year and fishing area

	1996	2001	2002
11			710
13	100*		
15		773	10,172

*single entry target SUR, method DI, species ECK

Seaweed Landings Database: green weight (kgs) by year and landing point

	1996	1997	1998	1999	2000	2001	2002
ECK1							590
ECK2	160	50				2	120
totals	**160**	**50**				**2**	**710**

ECK1 = Cape Runaway
ECK2 = Tatapouri, Emerald Pearls, Cape Runaway

Catch by method

15 All entries except one in Seaweed Estimates Database are by 'H'.

General Issues

16 *Ecklonia* may be harvested for biomass or for its constitutent compounds. Schiel & Nelson (1990) recommend that harvesting should occur in the winter-spring. Yields of extractable compounds such as alginate, mannitol, and laminarin, however, vary seasonally (Trenery 1985), and there may be pressure for harvests to occur at times that maximise yields of these compounds. For example, yields of alginate in April are 1.5 times that obtained in September, and yields of laminarin in May 10 times that obtained in September.

17 Because of the logistic difficulties in collecting attached stipitate laminarians such as *Ecklonia*, large scale hand collection seems unlikely unless there is a high value product associated. If SCUBA or dredge equipment is used then it is critical that only relatively small patches of *Ecklonia* are removed in order to assure recolonisation, and to minimise negative harvest impacts on associated fauna and flora.

18 Within the past 15 years there have been several episodes of mass die back of *Ecklonia* in north eastern New Zealand (e.g. Cole & Babcock 1996).

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