

## **Marlborough Environment Plan (MEP)**

# **Reflections on and Solutions to Mussel Farming Planning Issues in the Marlborough Sounds**

### **Kenepuru and Central Sounds Residents' Association**

## **1. Introduction**

- 1.1 The purpose of this paper is to identify what the KCSRA see as the key planning issues around mussel farming in the Marlborough Sounds and to table solutions for discussion within the Marlborough Environment Plan aquaculture provisions working group.
- 1.2 This paper is primarily addressed at mussel farming, which is the dominant aquaculture activity in the Kenepuru and Central Sounds area. The comments in this paper are not applicable to finfish farming. KCSRA believes that finfish farming should be addressed as a discrete activity in the MEP.
- 1.3 The adverse effects of mussel farming are, broadly put:
- Navigation safety and impedance
  - Visual amenity, landscape and natural character
  - Ecological – water column and benthic effects
  - Public access to the coastal marine area – water-sports, recreation, fishing, sailing, boating etc

## **2. Structure of this Paper**

- 2.1 This paper is structured as follows:
- Firstly we identify a couple of fundamental principles that we believe should be adhered to;
  - We then broadly identify the main regulatory framework;
  - We then identify what we see as the key issues that need to be determined;
  - We then expand on and discuss these key issues;
  - We then identify and discuss pragmatic planning solutions to the key issues.

## **3. Fundamental Principles**

- 3.1 KCSRA supports sustainable and environmentally integrated mussel farming in the Marlborough Sounds. In achieving this the MEP aquaculture provisions should be both objective and efficient.
- 3.2 *Baseline Principle*
- 3.2.1 At the outset it is appropriate to record the KCSRA position that the effects of marine farming in the Sounds must be assessed cumulatively and from a baseline of no marine

farms – irrespective of the degree or nature of historical anthropogenic changes that may have already been imposed on the Sounds. This is because historical anthropogenic environmental effects that cannot be avoided, mitigated or remedied do not condone further adverse effects today than can be avoided, mitigated or remedied.

### 3.3 *Public Interest Principle*

3.3.1 It is also appropriate to record that KCSRA sees the coastal marine area as a public asset that must be utilised optimally. This can only be achieved with some form of finite term consenting process. This is because what might be considered an optimal use of a public asset today might not be tomorrow. That is not to say that consenting cannot be rendered significantly more efficient than it currently is, such as through the adoption of an area by area marine farming assessment system – as outlined below.

## 4. **Regulatory Framework**

### 4.1 *NZCPS*

4.1.1 The New Zealand Coastal Policy Statement ('NZCPS') sets out the framework for addressing aquaculture in the MEP. Under the NZCPS:

1. We must identify areas where aquaculture development is inappropriate and areas where it is inappropriate without resource consent. We must also identify coastal processes, resources or values that are under threat or at significant risk from adverse cumulative effects and include provisions in the plan to manage these effects – including, where practicable, through the setting of thresholds (including zones, standards or targets) or limits to change to assist in determining when activities causing adverse cumulative effects are to be avoided (NZCPS 7); and
2. We must include in the plan provision for aquaculture activities in appropriate places, take account of the social and economic benefits of aquaculture, including any available assessments of national and regional economic benefits (NZCPS 8); and
3. We must avoid areas qualifying under NZCPS 11 (a) (i.e. adverse effects on threatened taxa, rare or threatened ecosystems and vegetation types, indigenous species habitat where the species are rare or at the end of their natural range, nationally significant examples of indigenous community types, other areas legislatively set aside for protection); and
4. We must avoid significant adverse effects in areas as per NZCPS 11 (b) (e.g. vulnerable coastal environments such as estuaries (i.e. the Sounds) and reefs, indigenous habitats important for recreational, commercial, traditional or cultural purposes, and habitats and routes important for migratory species etc); and
5. We must avoid adverse effects on natural character in areas with outstanding natural character and avoid significant adverse effects on natural character in all other areas of the coastal environment (NZCPS 13); and

6. We must promote the restoration and rehabilitation of the natural character of the coastal environment and include policies, rules and other methods in the plan that are directed at restoration or rehabilitation (NZCPS 14); and
7. We must avoid outstanding natural features and landscapes, and avoid significant adverse effects on other natural features and landscapes (NZCPS 15); and
8. We must recognise the need for public open space in the coastal marine environment for both active and passive recreation (NZCPS 18); and
9. We must give priority to improving water quality in areas where it is having a significant adverse effect on ecosystems, natural habitats, or water-based recreational activities, including by identifying such areas and including them in the plan and including provisions in the plan to address improving the water quality (NZCPS 21).

4.1.2 NZCPS 13 and 14 also require MDC to map at least high natural character areas (thus including outstanding natural character areas) and identify all areas that require objectives, policies and rules to protect natural character. NZCPS 15 requires MDC to identify landscapes by type and their need for protection and include the appropriate objectives, policies and rules to protect landscapes in the plan.

4.2 *Marlborough Sounds Resource Management Plan ('MSRMP')*

4.2.1 The MSRMP includes the following 'supplementary assessment criteria' ('SAC') for discretionary marine farming activity in the Sounds:

- Character of the benthic environment,
- Navigation matters, including adequate clearance from the shoreline, adjacent marine farms, jetties, log loading sites and other points of access to the shore, headlands, navigational routes, anchorages and mooring areas, water ski lanes and sub aqueous cables. A structure free access-way to shore may be required through larger farms.
- Aesthetic and cultural matters, including proximity to residences and land subdivided for residences, and
- The scenic, recreational, ecological, historical or traditional importance of the area, and
- Likely effect on commercial and recreational fishing, and
- The visual effect of the farm and its operation, and
- Likely effects on water quality and ecology, and
- The alienation of public space, and
- The extent to which the marine farm requires ancillary on-shore facilities.

4.2.2 KCSRA believes all of these SAC remain relevant today.

## 5. Key Issues to Determine

5.1 The key issues to determine are:

- *where* marine farming is appropriate within the Marlborough Sounds

- *how much* marine farming is appropriate
- how to render the resource consent process *significantly more objective and efficient*
- how to *transition* existing marine farming into new MEP aquaculture provisions, including where existing marine farming might not fall as environmentally acceptable under new MEP aquaculture provisions.

## 6. The Where Question

- 6.1 KCSRA supports the retention of zoning as an appropriate tool in terms of identifying where marine farming is inappropriate (NZCPS 7). All existing Coastal Marine Zone 1 areas in the Kenepuru and Central Sounds, including the head of Clova Bay, Tuhitarata Bay in Beatrix Bay and Hopai Bay in Crail Bay, should be retained as prohibited areas. The residential character, visual amenity, recreational, landscape, natural character and other values specific to these areas remain and must be protected.
- 6.2 KCSRA also believes that open seascape vistas in the Sounds must not be disturbed by marine farm structures and that open waters must remain free of marine farm structures for navigational safety. In short, marine farm development within the Sounds should retain the present pattern of being confined to an association with a land form.
- 6.3 A fundamental weakness of the current plan has nonetheless been the classification of marine farming *outside* of the preferred 200 metre zone as a non-complying activity. Assessments for non-complying activities have fallen under exactly the same SAC as discretionary activities and as a consequence most farms have now been extended out to well beyond the originally intended 200 metre limit from mean low water mark ('MLWM'). This plan weakness, coupled with systemic failures to address cumulative effects, has led to the current over-farming situation in the Kenepuru Sound and the Beatrix Bay, Clova Bay and Crail Bay area ('Beatrix Basin').
- 6.4 This can only be addressed with the desired level of consenting process objectivity and certainty if marine farming is a *prohibited* activity beyond designated parameters.
- 6.5 To this end KSCRA believes that the Kenepuru and Central Sounds prohibited zone should be extended to include all parts of the Kenepuru and central Pelorus Sound (including Beatrix Bay, Crail Bay, Clova Bay and the Tawhitnui Reach) that are *not* being farmed as at MEP aquaculture rules notification.
- 6.6 **In addition** to the above, mussel farming should *also* be *prohibited*:
- Within 100 meters of:
    - the MLWM, or
    - any sensitive benthic environment, or
    - any material reef, or
  - Within 200 meters of:
    - any trajectory to a headland or other terrestrial navigational way point, or
  - Within 500 meters of:
    - any jetty, launching ramp or other structured boating facility, or

- any water ski lane or other recognised recreational area, or
- any recognised navigation route, or
- To the extent that structures, whether or not jointly with other marine farm structures, will occupy more than 30% of the MLWM width of any part of a Defined Area (defined below), or
- To the extent that structures, whether or not jointly with other marine farm structures, necessarily render navigation through an embayment within 200m of marine farm structures, or
- To the extent there are structures within 1km of, and in direct view of, any dwelling, or
- In an area of outstanding natural landscape or feature or outstanding natural character – unless subsurface technology is used.

## 7. The How Much Question

7.1 As well as setting out base level parameters for *where* marine farming might be appropriate through zoning, it is imperative that objective cumulative effect thresholds for marine farming be set out in the MEP to dictate *how much* marine farming is appropriate in those areas where applications might be made. This is a requirement of NZCPS 7, and is particularly relevant in the Central Sounds given the over-farming situation in the Kenepuru and Beatrix Basin areas.

7.2 In this regard, thresholds or criteria should be clearly set out in the plan determining:

- When adverse cumulative effects of marine farming on natural character are significant (NZCPS 13); and
- When adverse cumulative effects of marine farming on natural features and natural landscapes are significant (NZCPS 15); and
- When adverse ecological effects on the Sounds are significant (NZCPS 11(b)) and where water quality is considered to be having a significant adverse effect on ecosystems and/or on natural habitats (NZCPS 21).

7.3 In accordance with this KCSRA believe the following objective **cumulative effect standards** ('CES') are appropriate – with each operating on a 'Defined Area' basis:

1. Marine farm structures must not occupy more than 10% of the surface area of a 'Defined Area' (NZCPS 7, 13 & 15).
2. Marine farm structures must not, cumulatively, render the natural landscape, natural character or any natural feature of a Defined Area at a lower point than it would otherwise stand on a 7 point assessment scale (NZCPS 7, 13 & 15).
3. Marine farming in a Defined Area must not exceed the Aquaculture Stewardship Council ('ASC') standards for the presence of free sulphides<sup>1</sup> (NZCPS 11).
4. Marine farming in a Defined Area must meet the ASC standards for ecological carrying capacity<sup>2</sup> (NZCPS 7).

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<sup>1</sup> See ASC Bivalve Standards 2012 – Appendix 1 at pages 30-31

5. Marine farming in a Defined Area must otherwise not give rise to significant adverse effects on water quality – including through a significant alteration to phytoplankton or zooplankton abundance or composition<sup>3</sup> (NZCPS 7, 11 & 21).

## 8. How to Render Mussel Farm Consenting More Efficient and Objective

### 8.1 *Defined Area Concept*

8.1.1 Resource consenting efficiency would also be greatly improved if environmentally acceptable levels of marine farming were pre-determined on an area by area basis ('Defined Areas'). To this end one-off 'Defined Area' assessments would be undertaken to determine the assimilative capacity of each Defined Area under the three broad heads - being:

1. natural character (CES' 1 & 2 above), and
2. natural landscape and features (CES' 1 & 2 above), and
3. ecological carrying capacity (CES' 3 – 5 above).

8.1.2 If marine farming in a Defined Area does *not* exceed any of the CES's under these heads then resource consent applications can be made and would need focus *only* on a few prescribed farm specific '*where*' matters, such as:

- whether the farm meets the objective standard for proximity to sensitive benthic environments, material reefs, headlands, navigational waypoints, recognised navigation routes, jettys, launching ramps, other boating facility structures, water ski lanes, other recognised recreational areas, or dwellings,
- whether the farm jointly or alone results in marine farm structures occupying more than 30% of the width between MLWM of any part of a Defined Area or necessarily render navigation through any Defined Area within 200m of marine farm structures,
- whether the farm is within an area of outstanding natural landscape, feature or character.

8.1.3 If marine farming in a Defined Area *does* exceed the CES threshold then resource consent applications can only be granted *to the extent* there is an entitlement under **Transitional Farm Rules** (see further below).

### 8.2 *Setting Defined Areas*

8.2.1 Defined Areas should be determined pragmatically – based on hydrodynamic and landscape/natural character consistency within each Defined Area.

8.2.2 Modern mapping technology renders actually mapping defined areas a relatively simple task. Attached is a map (Appendix 3) drawn from MDC's mapping platform that identifies 38 Defined Areas in the Marlborough Sounds and which might represent a pragmatic and effective delineation of Defined Areas. These areas are listed in Appendix 2.

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<sup>2</sup> See Appendix 1 attached for an example of these calculations for Defined Areas in the Beatrix Basin

<sup>3</sup> See Appendix 1 re Zooplankton

### 8.3 *Setting Cumulative Effects Standards*

8.3.1 The MEP should require Marlborough District Council to identify the relevant ‘Defined Areas’ for this purpose and then determine the CES under each of the 5 tests for each Defined Area (NZCPS 7). Marine farming activity within any Defined Area will be limited by the CES that demands the lowest level of activity in that particular Defined Area.

8.4 At a more detailed level the Defined Area assessment exercise would involve:

- Calculating the maximum percentage surface structure coverage in each Defined Area to meet the 10% surface coverage CES;
- An expert assessment of whether the existing level of farming is having a significant effect on natural landscape, natural features or natural character – by reference to any reduction in classification on a seven point scale – and if so provide a determination of what level of marine farming in the area would *not* give rise to such a reduction in classification on a seven point scale.
- A calculation of ecological carrying capacity under the ASC standard. If not met, a calculation of what level of farming in the Defined Area would meet the ASC standard. An example of these calculations for Defined Areas in the Beatrix Basin is attached as Appendix 1.
- A testing of sulphide levels against control sites under the ASC free sulphides standard. If not met, a determination of what intensity of farming would meet the ASC free sulphide standards.
- Determining whether the current level of mussel farming exceeds 20% zooplankton depletion and if so, a determination of what level of mussel farming would meet this standard<sup>4</sup> (i.e. runs the NIWA Biophysical Model with alternative levels of mussel farming)

8.5 The end result would be 5 CES’ for each Defined Area. The CES demanding the lowest level of mussel farming activity would set the threshold for mussel farming in that Defined Area.

8.6 Based on this MDC would determine, for each Defined Area:

1. Whether any farming retraction is required; and then
2. Whether and the extent to which this can be expected to occur over time due to re-consenting attrition as a result of activities falling as *prohibited* on farm specific assessment matters on renewal (e.g. because some existing farming activity in the area is within 100m of MLWM or reefs etc, or within 200m of any trajectory to a headland or other terrestrial waypoint, or within 1Km and in direct sight of a dwelling etc); and then
3. Calculating the balance of retraction needed, if any, after the expected farm specific retraction in 2 above is taken into account. We refer hereon to any balance of retraction required as ‘**Residual Retraction**’.

8.7 A variation to the above would be to require all farms beyond 250 meters from MLWM to be firstly reverted back to no more than 250 metres from MLWM on their renewals and to calculate any Residual Retraction still required after that. In this instance farm renewals

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<sup>4</sup> See further at Appendix 1

beyond 250m from MLWM would become *prohibited activities* to the extent determined by MDC when setting any Residual Retraction requirement for that particular Defined Area.

- 8.8 To protect CES ecological standards a maximum length of longlines (i.e. dropper lines) needs to be set per hectare of consented area.
- 8.9 This process would need to be completed by MDC within a set period (e.g. 12 months). The proposed Defined Areas and/or their CES thresholds would need to be contestable or open to review or declaration through the Environment Court.
- 8.10 *Note that this process is similar to the Ministerial approval process sanctioned by section 165ZF of the RMA where appropriate provisions for dealing with cumulative effects efficiently are not incorporated into a plan.*

## 9. How to Transition Farms into the New Aquaculture Provisions

### 9.1 *New Farm Applications*

- 9.1.1 Applications for any *additional or new* farming in a Defined Area that is determined as farmed beyond its CES threshold would be a *prohibited activity*.

### 9.2 *Existing Farm Applications*

- 9.2.1 The main transitional issue relates to the re-consenting of existing marine farms in Defined Areas where the CES threshold for the area is exceeded and where there is some Residual Retraction required in the area (as identified by MDC as part of CES threshold process).
- 9.2.2 Subject to section 128 RMA condition reviews (which, as an aside, should be considered in advance of re-consenting where over-farming is assessed as significant), it is assumed that existing farms in Defined Areas will have legal rights to remain for the duration of their existing consent terms notwithstanding the Defined Area may be farmed beyond the CES threshold.
- 9.2.3 Simple ordering rules would apply to resource consent applications for existing farms in Defined Areas that have been determined by MDC as having a Residual Retraction requirement.
- 9.2.4 These rules would simply provide for a fair allocation of the responsibility for the Residual Retraction required in the Defined Area. The default rule is that an application to renew a farm is a **prohibited activity to the extent** of the common percentage reduction that is required by all farms in the area (determined at the point the MEP aquaculture rules are tabled) in order to attain the required level of Residual Retraction.
- 9.2.5 As noted, the percentage of Residual Retraction required by all farms in a Defined Area would be identified by MDC as part of the Defined Area and CES threshold process. Farm renewal applications received pending finalisation of this process would necessarily need to be given a short term under section 123A of the RMA pending the completion of the Defined Area and CES process.



### 9.3 *Existing Farms in Prohibited Areas*

9.3.1 The other transitional issue relates to farms falling wholly in prohibited areas. There are 22 such farms in CMZ1. There is no basis for continuing to grandfather these farms. As such, unless relocated farms falling within prohibited areas should fall as prohibited activities on renewal.

## **10. Conclusion**

10.1 The above identifies what KCSRA see as the key planning issues for mussel farming in the Marlborough Sounds and poses objective, pragmatic and efficient planning mechanisms for addressing these issues.

10.2 The outcome is mussel farming activity that is appropriately integrated into the environment at acceptable levels. The public's right to contest for the optimal utility of public space is respected whilst there are objective standards, thresholds and processes that will bring about much greater consenting certainty and efficiency for the industry going forward.

**Trevor Offen**  
**Marine Sub-Committee**  
**KCSRA**

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## APPENDIX 1

### Example Ecological Cumulative Effect Standard Calculations

#### *ASC Calculation*

The Aquaculture Stewardship Council (ASC) standards provide that farming less than 10% of a water-body is prima facie acceptable<sup>5</sup>. Aquaculture New Zealand acknowledges the need to integrate with international standards in their “A+ Sustainable Management Framework” (‘AQNZ SMF’). The ASC pelagic standards are specifically acknowledged at Appendix 6 of the AQNZ SMF – albeit it simply noted there that “*ecosystem service exercises are to be developed in 2017*”.

The calculations below show Crail, Beatrix and Clova Bays have surface structure/cultured areas of the following percentages (these *exclude* warp line area):

- Beatrix Bay – 12.03% of the bay
- Clova Bay (including Otarata Bay) – 16.06% of the bay
- Crail Bay – 7.44% of the bay

According to ASC pelagic ecological carrying capacity calculations (attached), the following reductions are required to meet the ASC ecological carrying capacity standard in each bay:

- Beatrix Bay – Area farmed is greater than 10% so the ASC standard is not prima facie met. The calculations show that farming in Beatrix Bay needs to reduce by **36%** to meet the ASC standard.
- Clova Bay – Area farmed is greater than 10% so the ASC standard is not prima facie met. The calculations show that farming in Clova Bay needs to reduce by **68%** to meet the ASC standard. Clova Bay is the most intensely farmed bay in the Marlborough Sounds and this is likely to be the worst result of all Defined Areas.
- Crail Bay – being less than 10% farmed is considered acceptable under the ASC standard. However a supplementary calculation might be required for Elie Bay – a relatively intensely farmed bay at the bottom of Crail Bay.

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<sup>5</sup> Paragraph 2.2, Page 16 ASC Bivalve Standards 2012

**Aquaculture Stewardship Council Bivalve Standards (2012)**  
**Beatrix Basin Calculations**

*If retention time (i.e. flushing) is faster than clearance time (i.e. filtration) then the standard is automatically met. If retention time (flushing) is slower than clearance time (filtration) then primary production time must be at least 3 times faster than clearance time for the standard to be met.*

	Beatrix Bay	Crail Bay	Clova Bay	Beatrix Basin	Footnote
<b>Clearance Time Calculation:</b>					
Number of Days to Filter Entire Watercolumn (CT)	3.88	5.42	2.01	4.59	1
<b>Retention Time Calculations:</b>					
Estimated Flushing Time of Bay - Days (RT)	20	20	20	20	2
Is CT greater than RT using previous Beatrix Bay estimates of RT?	No	No	No	No	
Alternative RT Calculation per ASC Standard - Average Tidal Change (Metres)	1.7	1.7	1.7	1.7	
Therefore Average Water Volume Low Tide - Litres	546,000,000,000	378,392,000,000	139,629,000,000	1,289,600,000,000	
Therefore Average Water Volume High Tide - Litres	580,000,000,000	406,000,000,000	152,600,000,000	1,378,000,000,000	
Therefore RT Calculated As Per ASC Standard	8.97	7.69	6.10	8.17	3
Is CT greater than RT using ASC Tidal Exchange RT?	No	No	No	No	
<b>CT/RT Ratios:</b>					
CT/RT ratio based on previous estimates of Beatrix Bay RT	0.194	0.271	0.100	0.229	NB - Significantly <1
CT/RT ratio based on ASC Tidal Exchange RT	0.433	0.705	0.329	0.562	NB - Significantly <1
<b>Compare CT to Primary Production Time (PPT):</b>					
Estimated PPT	2	2	2	2	4
Therefore Minimum CT per ASC Standard	6	6	6	6	5
Is CT greater than 3 times the PPT time?	No	No	No	No	
<b>Farm Reduction Factor</b>					
Adjusted CT Given Reduced Farm Area	36%	10%	68%	24%	6
Is CT greater than 3 times the PPT time with reduced farm area?	6.07	6.02	6.27	6.04	
<b>Clearance Time Variables:</b>					
	Beatrix Bay	Crail Bay	Clova Bay	Beatrix Basin	
Total Surface Area - Hectares	2,000	1,624	763	5,200	
Total Surface Area - Square Metres	20,000,000	16,240,000	7,630,000	52,000,000	
Estimated Average Depth - Metres	29	25	20	27	
Cubic Meters Water	580,000,000	406,000,000	152,600,000	1,378,000,000	
Litres of Water	580,000,000,000	406,000,000,000	152,600,000,000	1,378,000,000,000	
Total Mussel Farm Coverage - Hectares	300	163	171	634	
Estimated Spat Catching area	25	25	31	81	
Reduction for Warp Line Area	12.50%	12.50%	12.50%	12.50%	
Therefore Cultured Occupation Area (Ha)	240.625	120.75	122.5	484	
Surface Structures as Percentage of Bay	12.03%	7.44%	16.06%	9.31%	
Length of Backbone per Hectare	1,300	1,300	1,300		7
Depth of Dropper Lines - Metres	15	15	15		8
Number of Dropper Lines per Metre of Backbone	1.14	1.14	1.14		9
Total Metres of Dropper Line per Hectare of Farm	22,159	22,159	22,159		
Number of Mussels per Metre of Dropper Line	140	140	140		10
Total Mussels per Hectare of Farm	3,102,273	3,102,273	3,102,273		
Filtration Rate - Litres per Day	200	200	200		11
Water Filtered Per Day per Hectare - Litres	620,454,545	620,454,545	620,454,545		
Water filtered per day by all farms	149,296,875,000	74,919,886,364	76,005,681,818	300,222,443,182	12

<b>Aquaculture Stewardship Council Bivalve Standards (2012)</b>	
<b>Beatrix Basin Calculations</b>	
<b>Footnotes:</b>	
<b>1</b>	Volume of Bay/Water Filtered Per Day - per Clearance Time Variables above.
<b>2</b>	Previous studies of Beatrix Bay have estimated the retention / flushing time to be 24 days (Sutton & Hadfield, 1997), and 20 days, varying from 12-27 for spring and neap tides respectively, by Heath (1976). Full exchange (dilution with Pelorus Sound ) 31.2 to 42 days (NIWA Biophysical Model Table 3.5 page 47).
<b>3</b>	$RT = -1 \times P / \ln(VI / Vt)$ Where P is the tidal periodicity, the length of the tidal cycle (e.g. ~0.5 days for semidiurnal tides) VI is the total volume of the water body at low tide (liters) Vt is the total volume of the water body at high tide.
<b>4</b>	PPT of 1-2 days under <i>reasonable</i> conditions (ASC, 2012) . 1-2 says is very conservative given the oligotrophic state of the Beatrix Basin.
<b>5</b>	ASC say if clearance time is faster than flushing time then primary production time must be at least 3 times faster than clearance time .
<b>6</b>	Percentage reduction in cultured farm area required to meet the ASC standard of CT > 3 times PPT
<b>7</b>	Double backbone per row, with rows 18 metres apart
<b>8</b>	From NIWA biophysical model; this is very conservative; e.g. Knight 2015 indicates 25 m dropper lines.
<b>9</b>	Based on 3,750m of dropper per 110m of backbone per NIWA Biophysical model page 57.
<b>10</b>	Average per metre of dropper per NIWA Biophysical Model Page 57.
<b>11</b>	<i>Gibbs</i> (1992) 14 litres per hour - 336 Lites per day; K Woodford (Lincoln University) 360 Litres per day.
<b>12</b>	Total cultured hectares x filter rate per hectare.

## *Appendix 1 – Continued*

### *Zooplankton Depletion – Cumulative Effect Standard*

Another leg of the ecological cumulative effect standards is zooplankton depletion. This has been recently determined on an area by area basis by the NIWA Biophysical Model. Currently the Beatrix Basin (Clova, Crail and Beatrix Bays) and the Kenepuru Defined Areas all record 90%+ consumption of zooplankton over summer months. Farming needs to reduce in these areas to the point that zooplankton consumption is at acceptable levels. A 20% consumption of zooplankton is a starting target. This is based loosely on the fact that Beatrix Bay has been assessed as now being effectively at *production* carrying capacity<sup>6</sup> - and we know that this is coming at a cost to the environment of 90%+ of zooplankton. *Ecological* carrying capacity has been assessed to be at around 20% of *production* carrying capacity<sup>7</sup>. On this basis an acceptable level of zooplankton depletion is 20% x 90% - say 20%. The NIWA model should thus be re-run to determine what level of farm reduction in the Beatrix Basin and the Kenepuru Sound is required to bring zooplankton consumption down to **no more than 20%**.

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<sup>6</sup> Hayden B, Ross A, James M, Hadfield M. and Gibbs M. (2000). Carrying capacity: the way to sustainable shellfish production. *Aquaculture Update* 25: 7–9; Mead, S.T. (2013). Desktop summary of current level of the science and understanding of the cumulative ecological impacts of mussel farms ring-fencing coastlines such as Beatrix Bay, Marlborough Sounds

<sup>7</sup> Jiang WM, Gibbs MT 2005. Predicting the carrying capacity of bivalve shellfish culture using a steady, linear food web model. *Aquaculture* 244 (1-4): 171-185

## APPENDIX 2

### KCSRA List of Defined Areas

These are:

Admiralty Bay Area	Kaiuma Area	Port Ligar Area
Anakoha Area	Kauaroa Bay Area	Port Underwood East Area
Beatrice Bay Area	Kenepuru East Area	Port Underwood West Area
Catherine Cove Area	Kenepuru Point Area	Richmond Bay Area
Clova Bay Area	Kenepuru West Area	South East Bay Area
Crail Bay Area (including Sub Areas A & B)	Maori Bay Area	Squally Cove Area (including Sub Areas A & B)
East Bay area	Marys Bay Area	Tawhitinui Reach Area
Fairy Bay Area	Melville Cove Area	Titirangi Area
Fitzroy Bay Area	Nikau Bay Area	Waihinau Bay Area
Forsyth Bay Area	Nydia Bay Area	Waitata Bay Area
Four Fathom Bay Area	Oyster Bay Area	Wilson Bay Area
Homewood Bay Area	Pig Bay Area	Yncyca Bay Area
Horseshoe Bay Area	Pipi Bay Area	



### APPENDIX 3

## MAP OF 38 DEFINED MARINE FARMING AREAS (See Page 6)

