Managing kina to 'kick-start' kelp forest recovery in the Maitai Bay Rāhui 2021 - 2022

A collection of planning and field notes

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Cover Photo: This is the natural control of kina abundance in motion, the photo was taken in the Leigh Marine Reserve. A big snapper can quickly smash a large kina. Large crayfish too are efficient predators of kina. Restoring these large predators to the Rāhui may take decades. We can help kelp reducing the kina numbers

For: Te Whanau Moana me Te Rorohuri

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Note: his collection of notes follows planning and trials undertaken at the Maitai Bay Rāhui which were conducted between April 2021 and March 2022. The notes are presented in four parts which simply follow the progression of the work over this time period.

Part 1 Notes and plans for kina barren work at Maitai Bay Rāhui - An introduction to the kina culling strategy aimed at assisting kelp recovery in kina barrens *April 3, 2021*

The aim of these notes is to help us collectively think about doing some active management of the kina barrens to assist the regeneration of the kelp forest. There are a range of benefits that could come with doing this work. We will have some good information about the kelp recovery. We can generate good information on kina density associated with good re-generation, poor regeneration or no re-generation of the kelp forest. If desired we can also generate information on kina health and quality to compare with the cover and health of the kelp forest. This could be useful in terms of guiding future traditional management of this resource. Before I get into the practical details, I will set out a few of the assumptions and issues we are dealing with here.

1.1 Playing God?

The idea of managing the kina at large scales and with a heavy hand (culling by smashing) to help the kelp forest restoration needs to be thought about carefully. We are playing God here, (usually not a smart thing for humans to do). Basically, we are trying to speed up the restoration process going on in the Rāhui by doing what the big snapper and crayfish would have done in the past, maintaining a natural balance between kina numbers and the process of kelp regeneration.

So what we are proposing is that in this period where large snapper and crayfish are returning to the reefs we trial controlling the kina density in a given area. We aim to keep the kina down to a desired 'natural' density so that the kelp can re-establish on the reef. We need to be really clear that ultimately we can not do the ecological job that snapper and crayfish need to do. We can only help the process on its way in very small areas that we can manage and learn from. We also need to be aware that kina are a food source for these key predators and are part of what attracts them to take up residence on the shallow reefs.

1.2 Hands-off or hands-on restoration?

We may have some surprises come our way about all this because Maitai Bay is not necessarily like all the other places where we have studied these processes. This is also a good reason to do these trials at Maitai Bay. If you look at our past you see Polynesians in general and Māori, in particular, went for hands-off methods of restoration as a preferred approach for restoration of fishing areas or rāhui of various types. However, Māori also had hands-on management processes they used which were carefully controlled. Examples are the seeding of shellfish, thinning of shellfish beds, specific strategies around the size or age of species they harvested or limitations on time of year, who did harvesting etc. Those are a few marine examples I am aware of. I am pretty sure that these 'hands-on' traditional practices arose only after a lot of learning and experimenting over long time periods. In a way, we are carrying on that learning tradition to solve a problem. That's a way to think about all this.

1.3 Some working assumptions:

- The kina barrens of Maitai Bay are in general large, decades old and very stable.

- Early indications from the monitoring as of years 4-5 is that the recovery of crayfish and fish species is beginning but is not rapid, it seems to be resembling the pattern at Leigh (approx. 15-20 years for kelp recovery) not like at Poor Knights which saw a rapid recovery of fish (4-6 years)

- What is the desired kina density? Research at Leigh indicated that a good target, to allow and maintain kelp naturally, is in the range of **1 kina per m^2 or less**. On kina barrens, there are typically many more kina than this, but there are also exceptions to the rule as well where kina barrens are very large and very bare, a result of the kina struggling to grow well. Once densities get up over 5-10 kina per m^2 we see 'feeding fronts' of kina established. This is a behaviour where the kina gang up along a line and literally march through the kelp mowing the kelp down as an army and eating everything as they go.

- On established kina barrens, current research indicates that even pretty low kina densities of 1-4 kina per m^2 can keep kina barrens from regenerating kelp stands.

- Until kina densities are naturally controlled by the predators (snapper and crayfish) in our trial areas we will need to maintain the kina density at the target level or below for the kelp forest to continue recovering and regenerating naturally after storms etc.6. We are also interested in the 'natural' recovery of kina barrens in the Rāhui. To track this process we want to have '**control areas**' alongside our 'trial management areas' where we regularly measure the kina density and kelp cover but **do not do any culling**.

Note: It is possible that any of these assumptions above could in reality be wrong or partially wrong. Research and practicing kaitiakitanga will from time to time expose some false assumptions or show us changes in how the Ocean is working. Nothing is completely static in the natural world. Exposure to false assumptions creates some of the most important of all lessons underpinning knowledge systems, so we should not be afraid of getting things wrong or having false starting assumptions as long as we learn the lessons from testing them.

1.4 Suggested trial management areas

Figure 1 An overview of the five trial areas, each is shown with two colours, the green is the shallow part of the trial areas where kina could be counted or culled by snorkel divers, and the light blue areas are the deeper trial areas where it would be more efficient to cull or count kina with scuba

Table 1 Calculated areas of the five management trials and three control areas.\

Name_2	Name	Area m2
Kb	kb	469,303
kb trial shallow	As	3,126
kb trial deep	Ad	1,393
kb trial shallow	Bs	1,149
kb trial deep	Bd	1,434
control	c2	5,015
kb trial deep	Cd	859
kb trial shallow	Cs	928

kb trial deep	Dd	616
kb trial shallow	Ds	1,363
kb trial shallow	Es	716
kb trial deep	Ed	326
control	c1	4,658
control	c3	3,672

Figures 2 & 3 below show an enlarged view of five trial management areas with the control areas included indicated by white line boundaries. The red dots are navigation marks to assist in locating the boundaries.

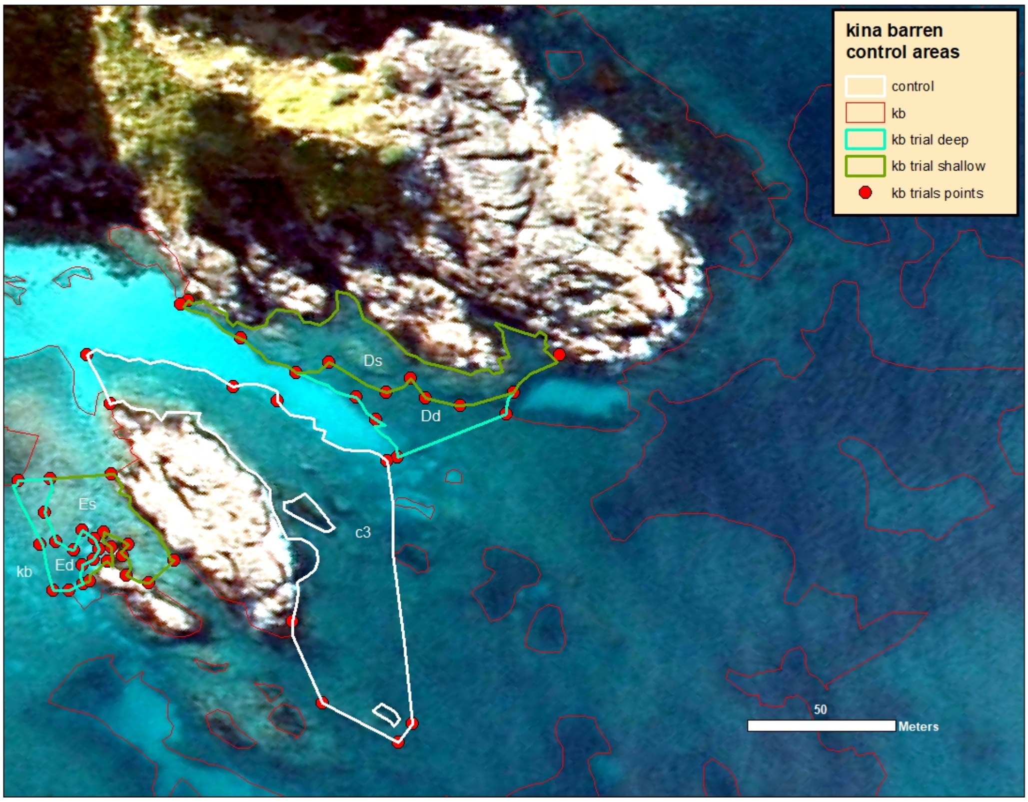

Figure 2 Two management trial areas and one control area at Waikura

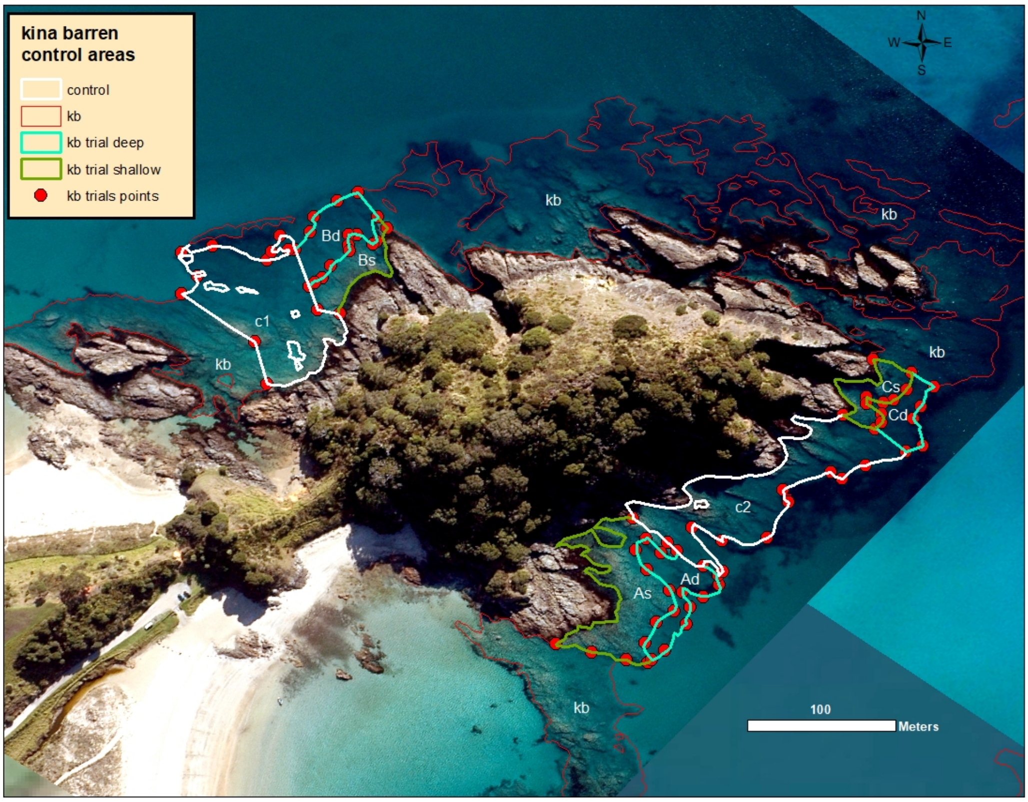

Figure 3 The three management trial areas and two control areas at Merita

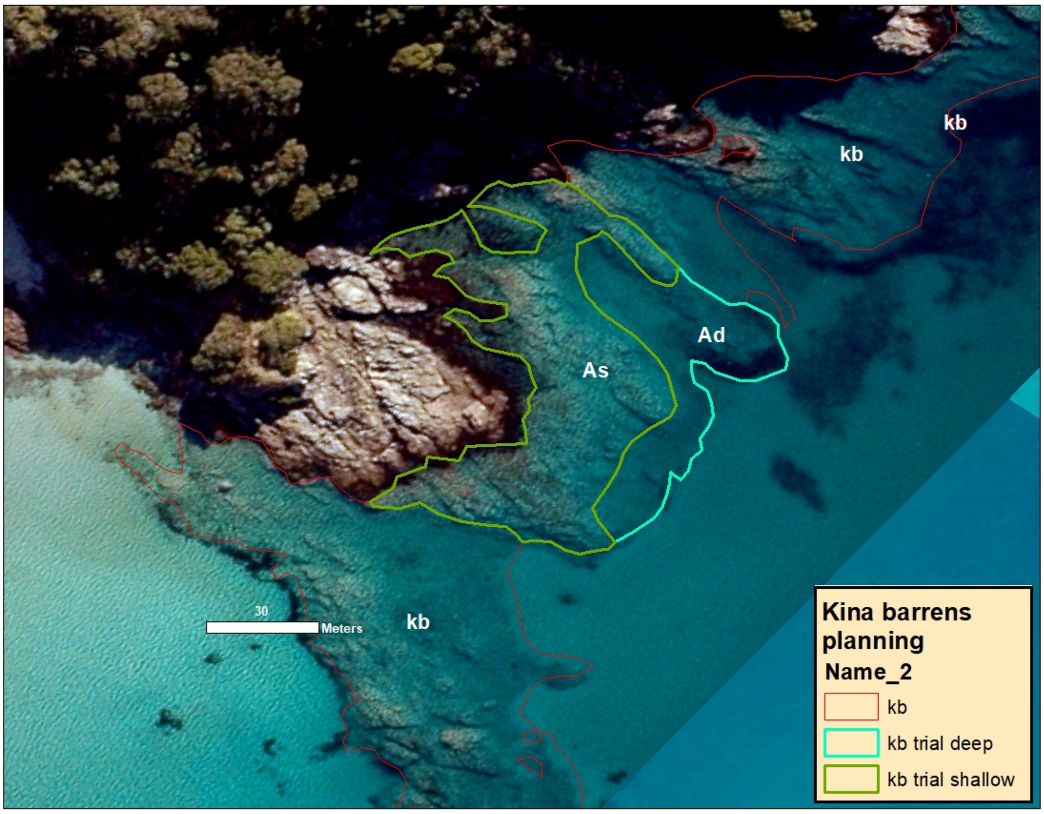

Figure 4 A closer view of the management trial area on the southwest side of Merita near the boat launching area

1.5 Outline of field methods

As a first task, we need to measure the current kina density of the trial management areas and the control areas. There are a number of ways of doing this that result in a range of very rough estimates to very accurate measures. Some options are:

1. visual assessment of the average kina per 1 m^2 density estimated from just swimming over the areas,
2. kina counts were obtained by randomly placing a 1 m^2 quadrat frame on the reef and counting kina in that frame,
3. transects permanently laid out and marked or random with 1 m^2 quadrat measured along the transect line,
4. **1 m^2 photo quadrats done from the surface by lowering a camera frame**

We are suggesting that we adopt **method four** using a GoPro photo frame pictured in Figure 5 below. Each of the methods has pros and cons associated with it but I am suggesting the camera frame because it gives you the best bang for buck in terms of time spent in the field and the quality of the data you get. It also has the advantage of measuring both kina density and kelp cover at the same time. It is very easy to use and you can lower the rig up and down in these shallow areas very fast. It would only take an hour or so to sample each of the trial areas producing say 20-30 randomly placed photo quadrats. Another significant advantage is that the photos can be kept for examination at any time in the future. This could have many advantages and help us answer future questions, which we are not even aware of currently. Many student projects could be created to look at this series of quadrat photos, for example, what lives on the kina barrens and is this changing?? The initial data we would generate from this photo quadrat would be:

1. average kina density for an area expressed as kina per m^2 and the range of high to low values
2. average percentage cover of kelp on the quadrat, and the range of high to low values
3. optional and desirable - we could produce estimates of the size of the kina and kelp plants

Note: At the end of this report I have attached some notes I prepared on the different 'levels' of measuring kina and culling for the purpose of him planning work with his students. In the future, any of these methods could be adapted for various purposes. They could support a return to customary harvest and management in the area or other areas and assist in keeping track of kina density and sizes. They could be adapted for educational projects suitable for various ages etc.

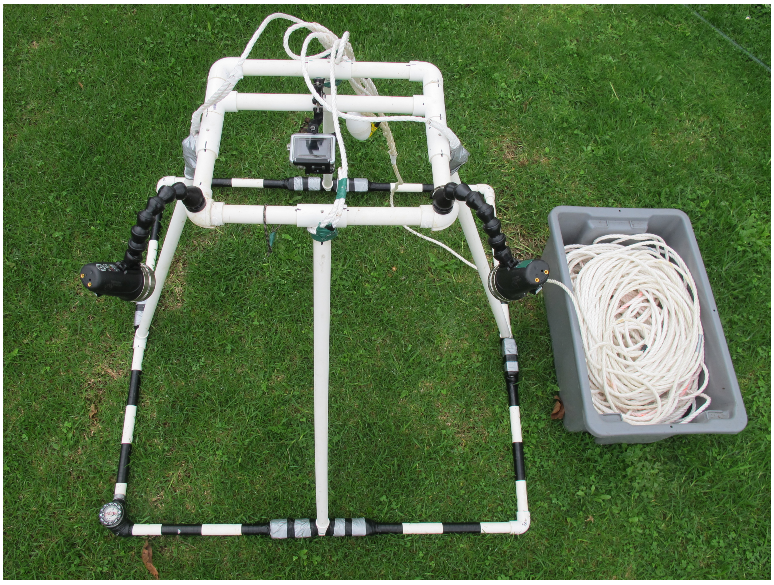

Figure 5 The 1 m^2 photo frame set up for a GoPro camera

1.6 Method for culling kina

The idea of the culling process is that in a marked management trial area you remove enough kina to achieve an average density 1 kina per m^2 or less. There are two basic options. The fastest is simply for the diver to swim over the area and smash kina with a hammer. The other option is to lift the kina off the reef and into a sack or dive bag which is taken to the boat or shore and removed from the reef.

The harder part of this task is estimating the density of the kina. This will take some practice but in time the divers will get an eye for it and be able to consistently cull the kina to the target density. Initially, it will be necessary to do some counting of the kina as the work proceeds. There are several ways of doing this as was explained in the previous section but the most practical way is for the diver to carry with him or her a 1m^2 PVC quadrat. These are cheap and easy to make and reasonably easy to move and use underwater. With a quadrant, the diver could visually assess a small sub-area and do the kina cull and then randomly place the quadrat in a number of different locations seeking to measure a reasonable average for the area just culled. Another way to work is to simply lay the quadrat down on the reef while the culling is underway continually moving the 1 m^2 quadrat to help with assessing the target density as the area is being worked on. This would slow the progress of the work but might be a helpful technique to help the divers learn to be thorough enough and consistent in the culling process.

1.7 Customary harvest

In theory, there is no reason the objective of culling the kina to reach a target density cannot be combined with harvesting the kina for eating. For any project in a traditional kina gathering area, this may be the context in which the project is planned and carried out. The important thing is that the requirements of getting the target density of kina are achieved in order to support the kelp system re-generation objective. How this process will work under local Tikanga will vary and it will be something for each Hapu to work through. Unfortunately, it is not simple because often the kina on the kina barrens do not often reach acceptable condition to be good eating due to the sparse diet.

1.8 Measurement of kina

During the process of culling the kina there is an opportunity to gather information on the kina itself. In traditional harvesting Māori have always had ways of describing the kina and the kina harvesting areas by size of the kina, quality of the roe, size of the roe, taste etc. This is the sort of information we are after. One simple method is to just measure size at any stage during the culling task by doing several collections of 50 kina and measuring their diameter with a simple marked measuring stick. Kina can also be sized from the photos generated by the photo frame set-up.

1.9 Kina condition

The next level of information looks at the 'condition' of the kina. This can be done with a qualitative description of a sample of kina, say rated on a 1-5 scale similar to how they are traditionally described. It is a useful exercise for the hapu to establish its own scale of kina size and quality based on the hapu knowledge of kina. What we are interested in here is the relative size of the roe and its colour. A description of its taste is helpful as well. This condition measurement can be done carefully to produce very accurate information by following a standard procedure where the roe is separated from the kina and then weighed with this weight compared to the size and total body weight of the kina. To do this accurately is a bit time-consuming but it may prove to be very helpful information to guide future traditional management of when and how to harvest kina alongside re-generation of the kelp forest.

To test the kina condition a suggested sampling approach would involve gathering kina from at least 5 locations in a management trial area with a minimum of 20 kina in each of the samples from the 5 locations.

There is also potential to use kina collected from kina barrens to restock other locations which have low numbers of kina and healthy kelp forest. The idea then is that they are harvested later. There is some potential in growing on kina in tanks commercially for export markets.

When considering collecting/harvesting strategies vs. culling, it is important to note that studies of kelp restoration projects have shown that collecting is 2 to 5x slower than smashing kina.

1.10 Marking out management trial and control areas

In designing the management and control trial areas, we looked for easy-to-locate boundary points on the shore like a point or distinctive rock. Underwater we looked for ridges or distinctive rocks to help form boundaries that divers could recognize and remember. I have also made GPS points as seen on the maps that are loaded onto our boat's sounder so the boat can be used to locate reference points for the corners etc.

For the seaward boundaries of the areas, a good way to mark the boundaries is with an anchor block with a floating rope going up to a buoy on the surface. A marker like this can be used temporarily when work is going on or they can be left for periods of time. An example of a block is in Figure 6 below.

Note: We have a dozen or so of these anchor blocks that are available for our use. They are made of concrete with a stainless steel eyebolt inserted in the concrete when it is poured into a mould.

Figure 6 An example of an anchor block for marking the seaward corners of the management trial areas

1.11 Frequency of monitoring kina density

In the beginning, we don't really know how often we need to check on our management trials. We are suggesting initially we aim to do an estimate of kina density 3-4 times a year. With the kelp monitoring once in summer would be fine. As we get to know the pattern of change with the kina twice a year or even once a year may be ok.

Part two Update on results kina density measurement trial, May 24th 2021

1.12 Measuring kina density

In the previous set of notes, 'Notes and plans for kina barren work at Maitai Bay Rāhui' *(April 3 2021)*, we gave a brief description of the sort of things we can try to help us learn more about managing and understanding kina alongside the restoration of kelp forests. There are options to choose from:

1. Do nothing
2. Do nothing to the kina but stop all fishing with the aim of recovering the natural balance between the predators and kina and the kelp forest
3. Allow harvesting of kina or encourage harvesting to restore the balance between kina and kelp forest
4. Carry out culling trials to try to assist and speed up the recovery of kelp beds
5. Use combinations of the above

We are suggesting that for all the options it would be useful to have a quick and efficient way to get an accurate count of kina in a given area of interest. Additionally, it would be useful to know when (if ever) the kina on the kina barrens are in harvestable condition.

We suggest that the GoPro photo frame dropped on a rope by a snorkeler is going to be our best method. We carried out a trial on May 20th near the gate to the South beach. The area sampled is the area mapped in the previous notes as Area As and Ad (see the map below). This update summarises the results of the trial and gives us some handy numbers on how long it takes to do this and the time to analyse the photos afterwards. This will help with planning future work.

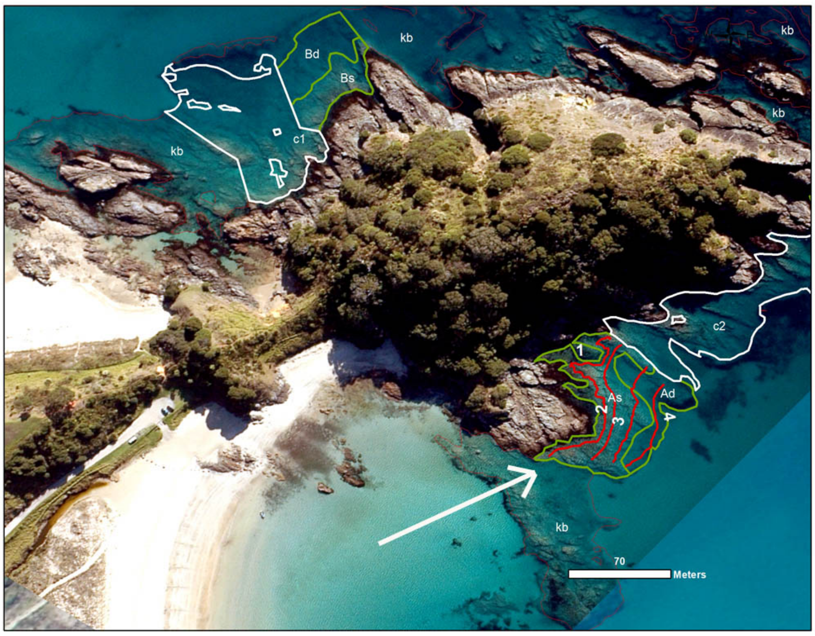

Figure 7 The white arrow points to the location of trial A surveyed, Area A is labeled As and Ad and bordered by a light green line

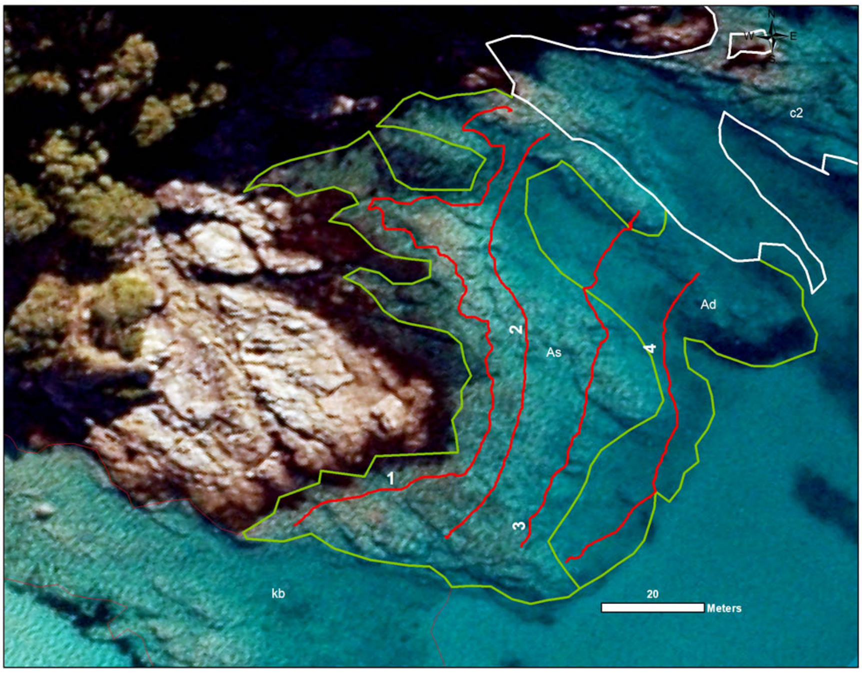

Figure 8 Area A trial area, the red lines indicate the four lines that were sampled, We tried to drop the photo frame roughly every 4-6 m swimming along these lines. The idea was to make each line at a certain depth along the reef. The photo frame camera was set to take a photo automatically every 5 seconds. The depths of the lines ranged from about 2m to 8m. Note: the red swim lines are approximately drawn freehand from memory after the dive.

1.13 Photo frame monitoring results

Area A size 4,518 m^2

Time to do the sampling in the water 47 minutes (not counting swimming to the site and back)

Initial processing of images – selection of images for processing 2 hours

Analysis of images – counting kina, algal % cover and notes on algal species and substrate 97 minutes for 72 drops

Total processing time 217 minutes, say 3.8 minutes/drop, which is 16 drops/hour including recording the algal species and % cover notes. If we just counted kina these processing times would be reduced. Also as we do more and more of this work we will get a bit faster.

Table 2 Kina density survey results

Line	Lenth (m)
1	158
2	87
3	75
4	66
total	**386**

Line	drops	avg depth drops (m)
1	33	4.8
2	17	5.1
3	11	6.8
4	11	6.0
total	**72**	**5.4**

Kb density result	kina/m2 avg	range kina/m2
line 1	10.5	0 -65
line 2	6.5	0 - 18
line 3	1.6	0 - 8
line 4	3.2	0 - 50

total kina count	506
overall avg	**7**

Based on this data the total number of kina living on the Area A portion of the reef would be estimated at: 7 kina /m^2 x 4,518 m^2 = 31,626 kina

1.14 Observations

The overall average kina density came out at 7 kina/m^2. This is probably in the range of what was expected and is definitely enough kina to maintain the kina barren in a stable state.

The snorkel task and the analysis task could be easily learned by anyone who was keen including our younger kaitiaki as long as the overall supervision was Ok.

The photo frame gives us a really good view of the young kelp plants just starting to grow on the reef. This will be really interesting and useful.

1.15 What's next for us in this project?

We could carry on with a bit of work through the winter too:

1. Collect kina density information on the reefs we are interested in both areas where we intend to cull kina, maybe open to harvest, or leave to restore fully naturally. To be able to compare results from these three options will be really useful information for all kaitiaki groups and us. It would be good to have one count done on all the areas we are interested in before we start any culling operation in the Spring or Summer.

2. We could do the first culling trials to test our ideas, and the technique and learn the practical things doing the job. We would get a lot out of it and be in a better place to involve more people in the Spring and Summer.

3. Focus on selecting people who could work on this project – we could start this now. There will be the on-the-water job and there will be a job for someone to count the kina in the images on the computer. The Sooner we find people to join our kaitiaki crew and begin the training involved the better.

It would be good for a small group of us that are interested to sit down and make some decisions on all these next steps. We need to know that each of these things that we are recommending is in fact the best way to go from the point of view of the hapu and our long-term direction. It would be good to review what we have done in suggesting the trial and control areas for the culling. Too big, too small, best places etc.?

Here are some examples of what the images look like from the photo frame:

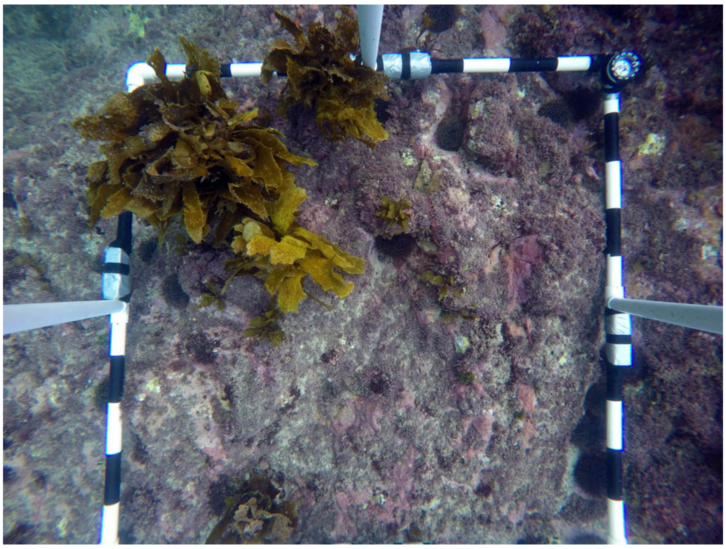

Figure 9 Line 1 *Ecklonia* in top right corner, how many kina in the frame?

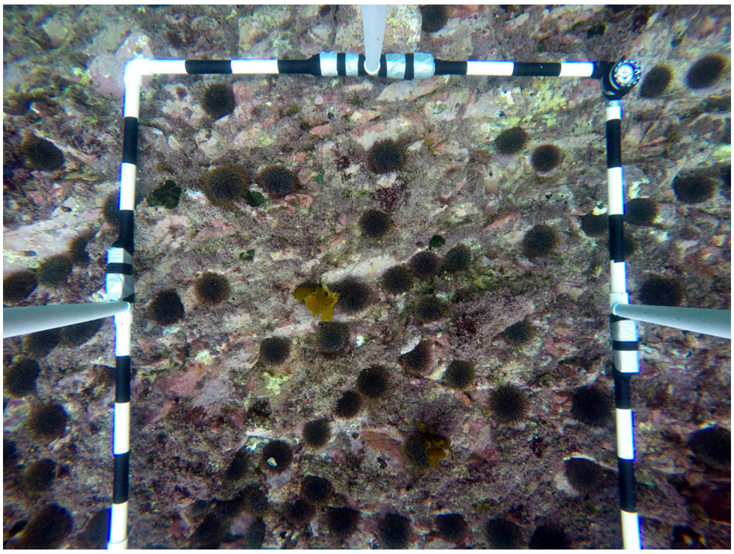

Figure 10 Line 1 an example of high numbers of kina

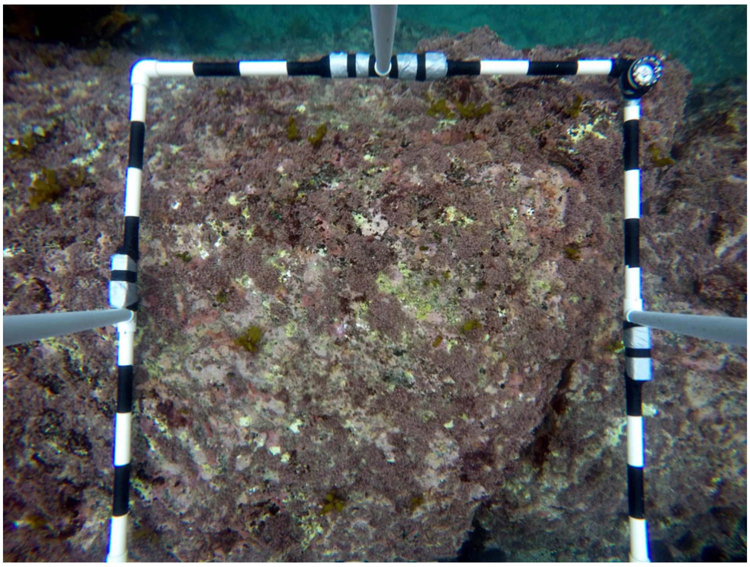

Figure 11 Line 1 an example of a bare area with no kina visible but notice the crack lower right where some kina are lurking. This pattern of some bare areas and some areas with high counts are typical.

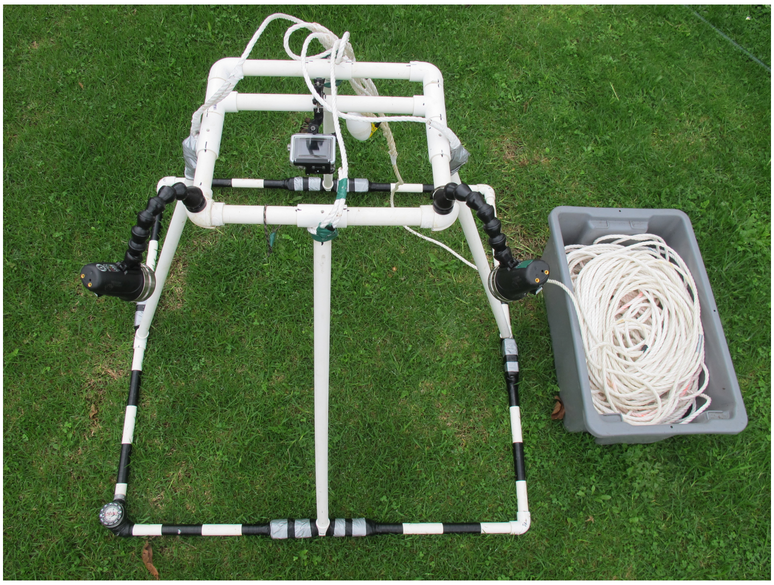

Figure 12 The GoPro photo frame we are using, (we don't need lights for this job)

Part three - Kina Culling Trial Notes Maitai Bay Feb 17th 2022

The next stage for trials (Summer 2022) was focused on the practical aspects of actually doing the culling work. The following was targeted:

How hard is this to do?

How long does it take?

What is the best method?

Can we usefully use snorkelers in the shallowest part of the reef?

What are the best tools?

What skills/experience/motivation etc. will be required from the dive team that does the work?

How will we supervise the work and be confident we are getting the culling done well enough which means achieving a density of less than 1 kina/m2 or zero kina?

What training may be required and how and who will do this?

Are there possibilities to support the mahi using harvesting at certain times?

1.16 The kina culling job

We decided to test the idea that it may be worthwhile to do the shallowest part of the reef with a snorkeler working alongside and diver on scuba. The area we started on was the shoreline down to about 3-4 m depth of our trial area. This is within the area that we surveyed last May (2021) to trial estimating kina density on the reef. That data helped estimate how much diver effort would be required to cull the kina from say a hectare or ½ hectare of our shallow reefs in the Bay. The area within the white boundary is roughly the area we cleared of kina in two dives, the first ½ hour and the second dive the second was 1 hour long.

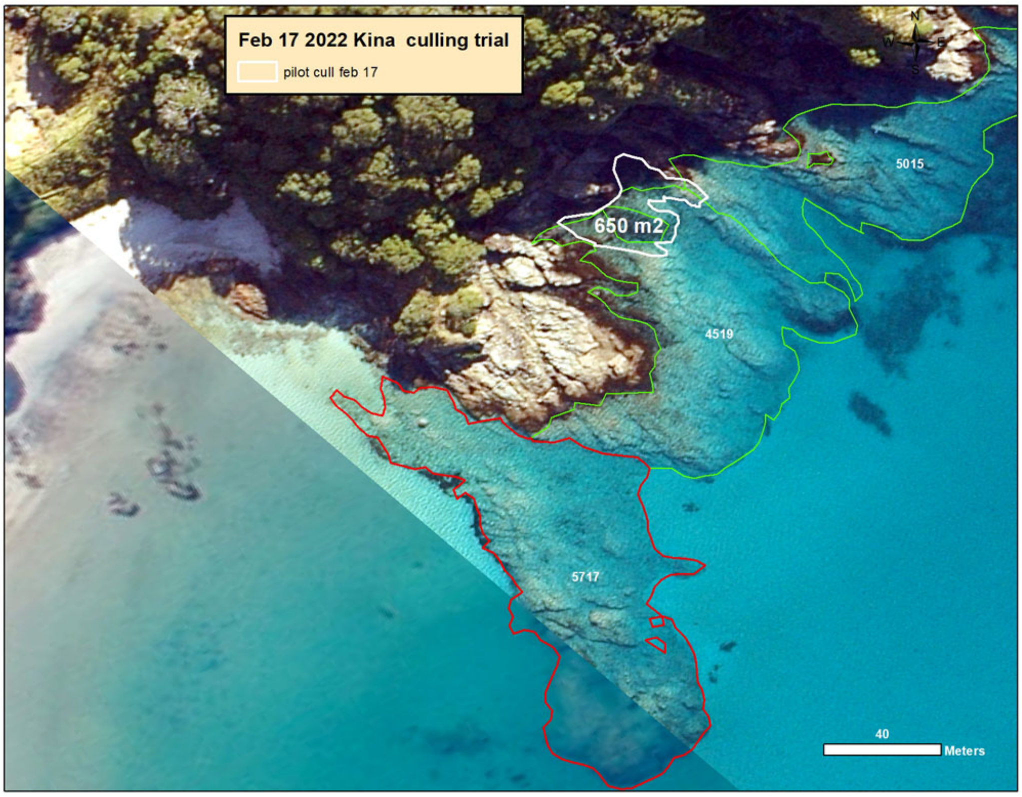

Figure 13 The area surrounded by a white line is the area we cleared of kina in this first trial. It is within the green boundary of reef Area 3. This is near the gate to the beach where we launch the boats.

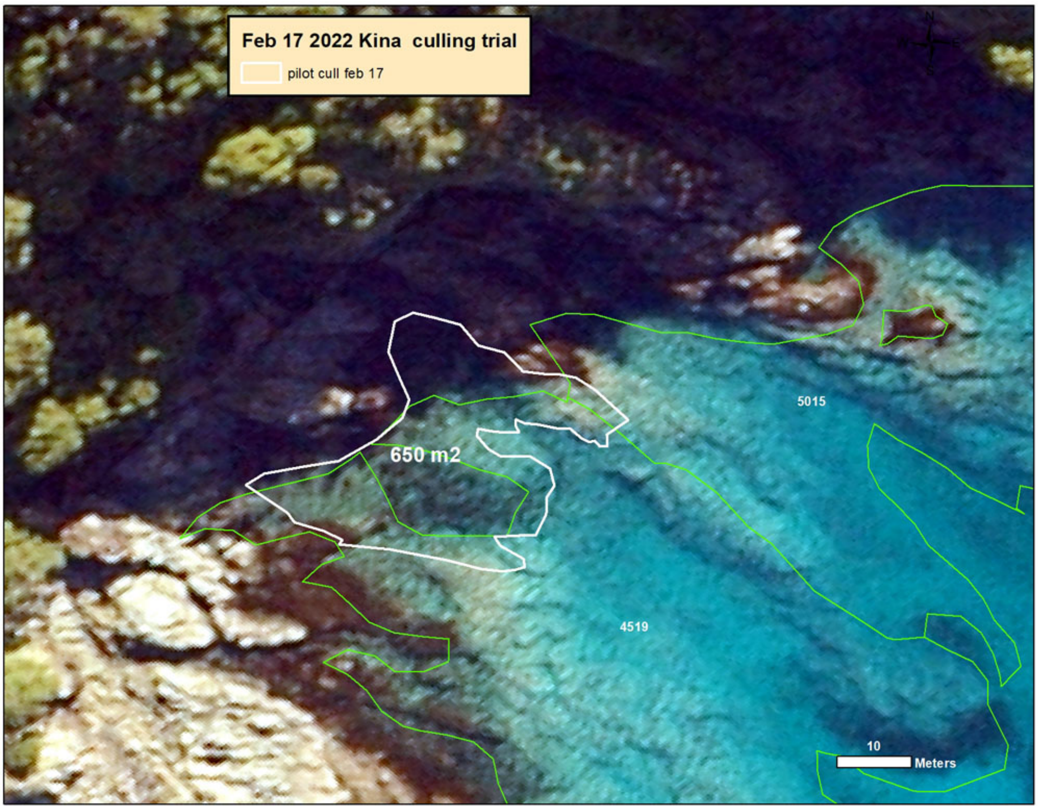

Figure 14 This is an enlargement of the area where we did the culling trial

1.17 Snorkel method tested

What we attempted was for the snorkeler to work the top of the shallow zone basically from the shore down to about 2m maybe 3m depth. This zone of course was affected by the tide. We did this diving when the tide was receding at about ¾ - ½ of full tide. Full tide conditions make life harder for a snorkeler but tide level doesn't really affect the diver on scuba. The scuba diver worked from where the snorkeler stopped on the slope of the reef and tried to do a band down to 3-4 m depth. The divers focused on coordinating their effort and staying together as they moved along the reef shoreline. The divers aimed at not missing any kina which is not to easy achieve.

1.18 Tools

Unfortunately, we did not have hammers on this first culling day, so we tried different rocks of various shapes and screwdrivers. This turned out to be a critical part of the job as it is surprising how difficult it is to smash large numbers of kina quickly and efficiently. The best tool question was addressed in a further dive.

To help visualise what this looks like underwater we have included below some photos from last May taken from the areas where we did the culling.

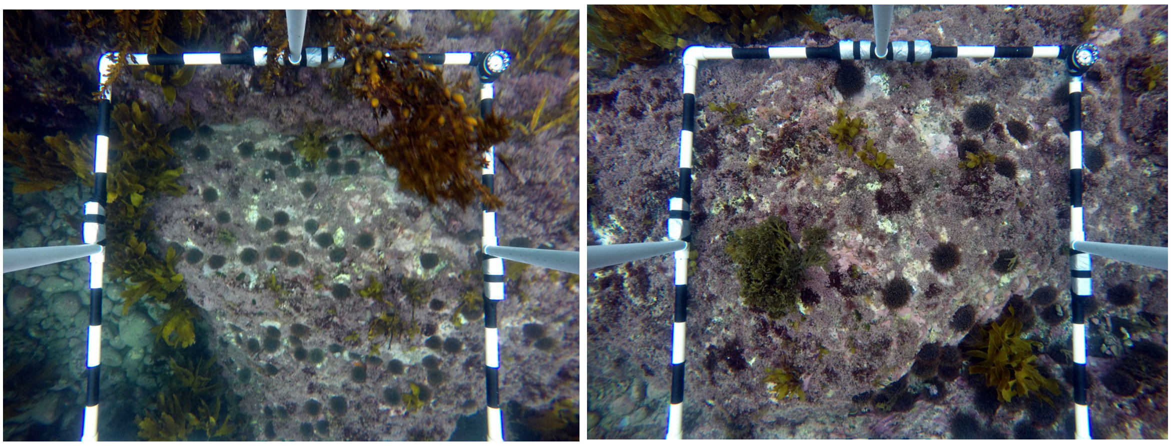

Figure 15 This is an example of high kina numbers getting up to 20-30 kina per m2

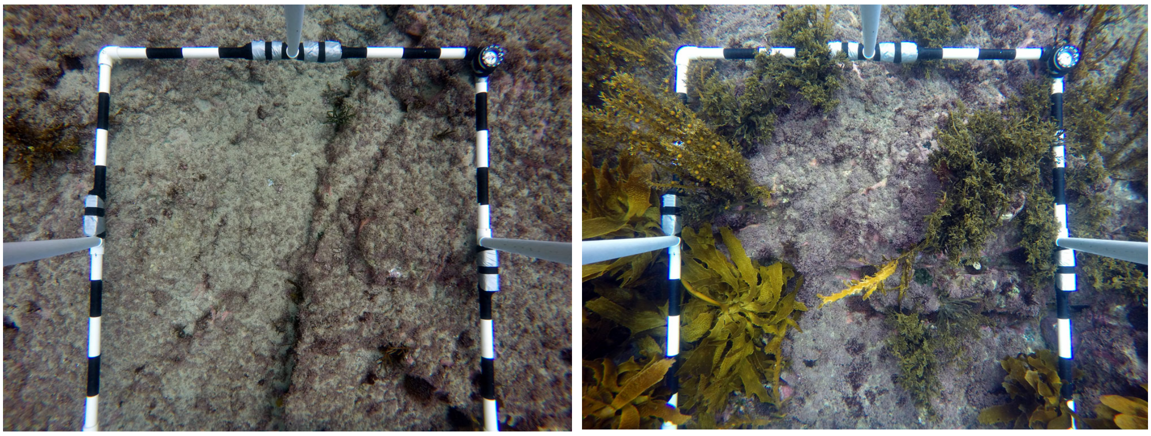

Figure 16 These are examples of more typical kina densities of between 1-10 kina per m2. Notice the cracks in the right photo, it is common for kina to be well hidden in cracks during the day, which provides another challenge to the divers to find and smash these kina.

Table 3 These are the averages of kina/m2 for the four lines surveyed and the range of counts recorded along each line range being the lowest count to the highest count.

Kb density result	**kina/m2 avg**	**range kina/m2**
line 1	10.5	0 -65
line 2	6.5	0 - 18
line 3	1.6	0 - 8
line 4	3.2	0 - 50

1.19 Variations in terrain and kina density

Looking at the data, and from our own experience in the water, there is a great deal of variation in where the kina are in large or small numbers and also the terrain. These two things and the depth range and where the kelp is (their food) all vary across the reef. The point of saying this is that the terrain and kina numbers have a very big impact on how long it takes to do this job.

1.20 The use of snorkelers for this work:

Our conclusion is that snorkelling has limited potential. Our two divers in these trials are experienced and competent. Both diving approaches require good diving skills and actually are quite demanding. It is not easy work as you are maintaining good bouncy control, navigating finding the kina and hitting each kina accurately continuously with no resting and no tolerance for missing kina as you go. The rate a snorkeler can get through this work is obviously a lot slower than what a diver on scuba could do. The obvious reason is simply the time it takes for the snorkeler to come to the surface and breath and recover from each dive. Another difficulty with the snorkeler/scuba diver pairing is that it is hard for both divers to maintain an even line to match up with the other diver, whereas two (or more) scuba divers can continuously swim side-by-side maintaining an even path that each diver is responsible for.

One possible exception to our recommendation here is that a snorkeler or team of snorkelers could go through the shallowest part of the reef before the divers went through and simply do as much as they could and be as thorough as possible. Then the scuba divers go through with their first pass and tidy up the shallowest part of the reef. This allows for more people to be involved which may become an important outcome of the work. It could potentially save a fair bit of scuba time.

1.21 Rate of work and variations in kina density and terrain

Imagine doing this work and comparing how long it would take you to cull the kina on the flat reef with no cracks and a low kina density of 1-5 kina/m2 compared to an area of 40-60 kina/m2 with cracks or ledges or big boulders. The difference in time could be as much as 10x based on what we did in terms of the area covered. Fortunately as was illustrated in the work we did in May the really dense difficult areas of kina are not that big and occur only in some parts of the reef, so for our reefs on average the divers would be faced with less than 10 kina/m2 and there are some large areas with even less kina and just clean flat rock. But that said in areas like where we dived with high kina numbers and complex habitats the time to cover a given area dramatically slows down.

1.22 Estimating the numbers and how much work is involved

This estimate is based on the all the notes we have made talking to the Auckland University team after last summer and taking into account the summary of what has been experienced with overseas projects. It is what we can start with but obviously, we need numbers generated from our reefs before we can be confident.

The table below (Table 2) is an estimate we made for our 2022 Monitoring Plan to help me come up with a budget figure for doing this work.

Table 2 Estimated work effort required to cull Area 3 (green boundary Maps 1 & 2)

Area Name	Hectares	Square meters	Estimated # Kina @ 7 kina/m2 density	number of dives 1 diver one tank @ estimated rate of culling 15 kina per minute	number of dives for a team of three divers	number of days work 3 dives, 3 divers
Area 3	0.452	4,519	31,633	35.1	11.7	3.9

1.23 Work rates calculated from our culling trial

We culled kina in our trial in area 650m^2 in 1.5 dives (2 divers). We believe this area has considerably higher density of kina than the average for the whole of Area 3 which was estimated at 7 kina/m^2 (total of 31,000 kina). Line 1 in the May survey had an average density of over 10 kina/m^2. In our two dives, we spent a ½ hour in a small area where density was around 40 kina/m^2 or more and the rest was the shoreline edge of the reef. We think an average of 10 kina/m^2 would be a realistic average for the area we dived. It is safe to assume that in areas of high-density kina/m^2 you would cull more per minute but as well cover less area. Using a range of 7-15 kina/minute as a rate the Auckland University team have achieved at a 1 ha scale, (pers coms Kelsey Miller and Nick Shears), this means we culled something like between 1 and 2,000 kina. At this rate, if the average density measured in May for the whole of Area 3 is reasonable that means two divers would have to do a total of 15 – 30 dives to complete Area 3 (bordered by the green line in Maps 1 & 2). That is a considerable commitment for an area of reef that is only about ½ of a hectare. Once we are experienced at the tasks and get real figures from the 'easier' parts of the reef, the best tools and practice the method, we may achieve better work rates. That said this is not an easy task, there is a lot of focus required and good diving skills required. Productivity will be much lower with less experienced divers or divers in training.

1.24 Kina Condition

After the culling work was completed we took a random sample of 27 kina. We opened all 27 kina to check for 'condition'. We plan to do this each time we do the diving. The purpose here is to learn more about the possibilities to use harvest at certain times to cull kina on the kina barrens.

We opened all 27 kina and they were very consistent in 'condition'. We didn't measure their diameter this time but we will in future. I would give these kina a 1.5 out of 5 with scores of 4 and 5 being ones worth bringing home. We have seen worse that are starving which I would score as 1 or less than 1.

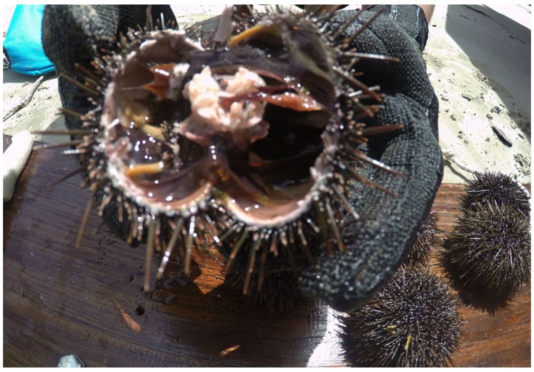 

Figure 17 Photos 3 & 4

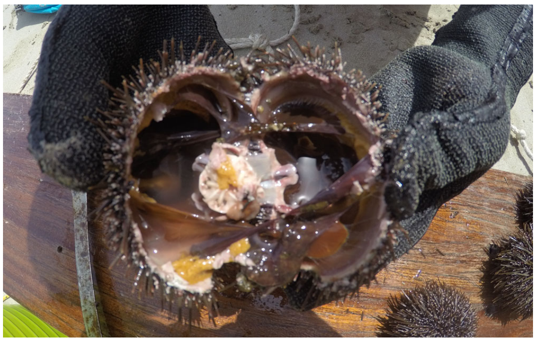 

Figure 18 Photos 5 & 6

Figure 19 Photo 7 **-** This photo is here simply for comparison, it is a generic photo I have in my photo archive and not taken at Maitai Bay.

Part Four March 16th second trial of culling technique and tools

This trial looked at a way to organise the divers so as to work efficiently and not miss any kina. The dive was carried out at the same trial site where we had culled kina on Feb 16th.

There was some re-invasion of kina in the area we had earlier culled but it was isolated and relatively minor.

1.25 Preferred tools

We tested a variety of hammers of different sizes and types on this dive and a small hatchet. They all worked but one stood out as being more efficient and is shown in Figure 20 below. This hammer is a bit heavier than a standard hammer which we felt worked better underwater. It also had a rock hammer shape with a chisel-shaped end, which seemed to work well. This may appear to be a trivial matter, however, the constant hammering involved in this task and the need to accurately strike and crush the kina in one fast blow is key to working at the best rate possible. To conclude hammers were the preferred tools by some margin. We also felt it could be a help to carry a poking stick, like a long screwdriver. Often the kina are well hidden in cracks and the stick or screwdriver is effective at either levering the kina out of the cracks or puncturing them.

Figure 20 The preferred hammer with a chisel-shaped end, note safety string, normal practice in diving is that all tools need to have a way to be attached to the diver or can be attached quickly to allow the diver to have his hands free in case issues arise with the diving equipment.

1.26 Ideas for diver navigation and technique

From the experience of the earlier trials, we decided to test a method where two scuba divers swim close together in a zigzag route up or down the reef along a predetermined belt or transect of approximately 5-6m width. This method worked pretty well in terms of divers being able to easily see each other and where each diver was working. Using this zigzag path method all areas were double-checked as the divers worked up or down the swath of reef.

It is suggested these transects or swaths of the reef could be marked visually with a weight on the bottom attached to a floating line with surface float, (see Figure 6). This would help to keep the divers on a consistent path over the reef as they worked and mark the edges for the next swath to start from. From a dive management point of view, it would be preferred to work from deep to shallow. This would be the best way to minimise the bad effects of having to move up and down vertically repeatedly in shallow water. It is also easier to maintain good accurate buoyancy control working from deep to shallow in the suggested manner. Inexperienced divers will find this challenging.

A critical part of this job is that no areas or kina are missed and every effort is made to find the more cryptic kina hiding in cracks. We have tried to depict what this method would look like on a map below.

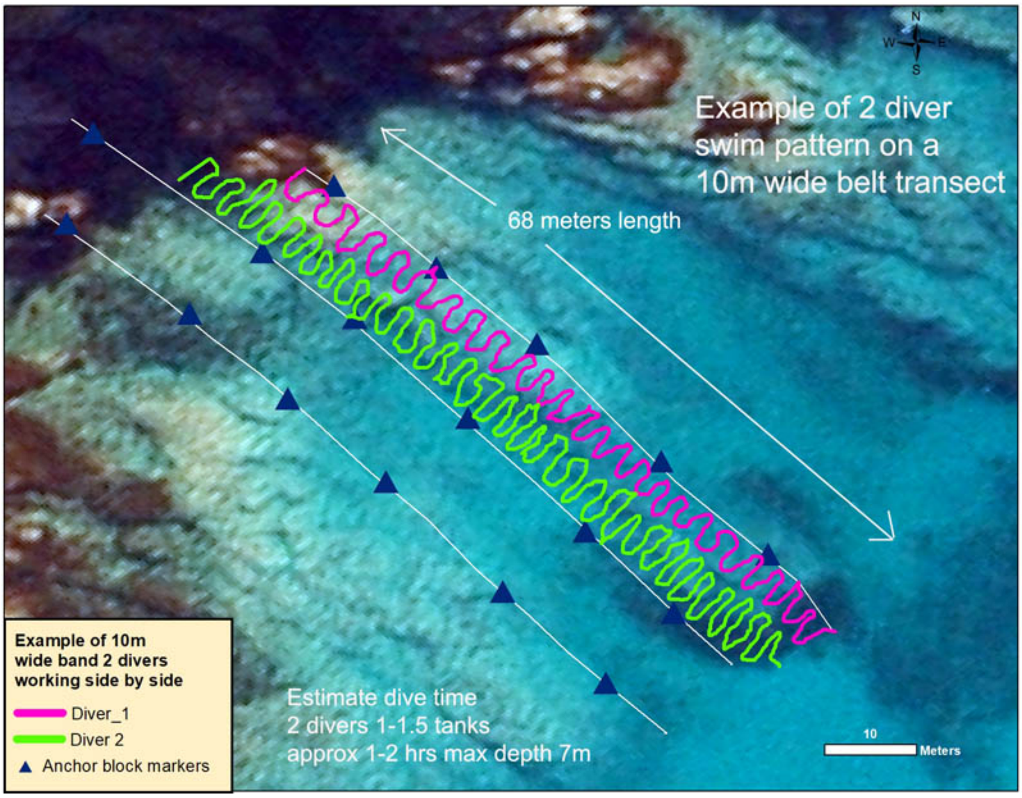

Figure 21 The belt transect 2 diver method as described above. The transect is approx. 68 m long and 680 m^2 in area, similar in area to the culling trial described in Part 3. The location in this image Area A is the same as the culling trial (Figures 13 & 14) and kina density counting trials (Figures 7 & 8).

Notes on involving school groups in the kelp reforestation work at Maitai Bay

I have laid out some things that a group could make a start with, once we take the step that goes beyond looking and learning we will need to present this to the rāhui committee for review and to make sure we are solid in terms of the overall Kaupapa and Tikanga

Timed Swims level 1

keeping in mind that the main goal initially is for them to experience stuff and have time in the water. So some structure around that could be in the form of practising:

1. their snorkel skills
2. swimming quietly
3. identifying fish species
4. recording fish species
5. learning the timed swim method

Around these first five things, there are various classroom learning things that you could do. It is good to have them practice with a video and also with pictures.

Involvement in Kina monitoring.

It is possible for this second level to begin with simply swimming and observing the reef and asking questions like roughly how much kelp is there, how many kina are there, how big are they, and what would this be like on a healthy reef? Let them explore and approach the questions any way they want initially. Could spend a lot of time improving snorkel skills, and observation skills and learning about what we are working with. Before we start the more serious stuff we want them to be motivated and quite competent in snorkelling. There's a basic rule about doing marine science, no actual worthwhile work should be attempted until the appropriate water skill levels are there. There is obviously a safety reason for this but also it is about the work itself and the quality of what information you produce. Also hopefully they will become motivated around the project as their skills and experience in the water grow. Some of the things that they could learn to do are:

1. practice basic snorkel skills
2. In quite shallow water layout a transect line
3. count kina in a quadrat (square of PVC pipe that you can easily make or use mine)
4. learn to measure the size of kina while diving
5. record on a slate kina counts and sizes
6. do the same with kelp Steps 2-5, kelp can be measured by how much of the quadrat is 'covered' by the kelp canopy and also the height

More advanced

1. harvest x number of kina and score them for 'quality' or condition, you could use a traditional measure but what we are interested in is the weight of roe that we compare to the kina size. I could help with sorting a simple way of doing this, we can probably do it by taking the roe out and measuring it by volume which we can translate afterwards to weight.

Notes:

These transects, they can be randomly located on a study reef but that really only works if the number of transects is high not for a small number. Alternatively, we permanently mark the transects which can be done in several ways, which we can discuss and work out a system for. For starters, we only need one transect.

The third level of this is we have areas marked out where we control the kina population this is a way to do this.

Mark out the controlled area

Establish at least three permanent transects for monitoring the algal recovery and the kina numbers and sizes condition etc Alternatively we could do random sampling of quadrats but we would have to be a bit careful to be random and do enough of them to make it work.

We decide on a target say average 2 kina per square meter. Then we work over the entire 'management trial area' of the reef selected and cull kina to roughly fit that density.

Alternately there could be some sort of harvest for eating around this same goal, but as you can imagine this does involve organising people and time etc around the goal of the kaupapa which is to learn from doing the culling. If we are not careful and consistent with this process it will be hard to draw firm conclusions about the learning part.

With this experiment of controlling kina what becomes important is the follow-up monitoring, if our objective is to learn how the process is working we need to monitor something like 4x per year to keep kina density in the desired range and to track recruitment of kelp on the controlled area

Another option for monitoring is photo transects which could be done from a boat or kayak and are completely viable. I have a 1 m quadrat GoPro photo frame set-up that you simply drop down on the reef, sampling can be random because you do many samples and then you do the counts back at school on the computer - it could be a good option.

Notes: With the kina control idea there are two basic approaches both of which can involve customary harvest and consumption if desired

Approach A: control can be regularly carried out in a given area and maintained by harvest or smashing, there is no formal monitoring, we rely on our observations to see the results happen over time. In a scientific sense, we don't really prove anything as we haven't measured things as we went. But we are observing and doing it this way we could cover much more area which may be a priority. Traditional management is based on seeing observing and thinking about it and feeling and relating all of this to the stories and knowledge handed down over long periods. A strict science approach is not necessarily better than the traditional system but it may at times simply help observations to be more accurate or focused. The science approach suffers greatly from not having the benefit of the long view and the lessons learned from some very smart people of the past.

Approach B: we control smaller areas and carefully measure kina and kelp recruitment as we go and learn in some detail what is actually going on, disadvantage is that we cover much smaller areas this way

Approach C: we combine both A& B approaches and have benefits from both, learn what is going on and refine our methods of how to do this at Maitai Bay. As we get a result this creates the confidence and know-how to progress restoration at larger scales.

If school projects get going it would be helpful to have three reasonably small areas of the reef at Merita, Waikura and over Blue Maomao Pt way. One good thing about this work with the kina is that you can do these things right through the year not just in summer as in the fish work. No reason that what we do which is aimed at getting a clear and measurable result can't run in parallel with what the school is doing on the 'training reef(s)'. The more info we get the better and if we are lucky some of the students in time may become motivated and far more capable to contribute to the monitoring program. This kelp restoration work would be ideal for attracting further funding support.

1.27 Notes: Research Permits, kina and the Fisheries Act

Kina is a quota species in New Zealand under the Fisheries Act and is subject to regulations for amateur and commercial fishing. The idea of culling kina for the purpose of restoring ecological balance between kina density and kelp browsing and recovery of kina barrens to a natural kelp forest is relatively new in New Zealand. At this stage the only mechanism under the Fisheries Act to carry out kina culling at large scales is to apply for a research permit from MPI. Hopefully in future this can be a streamlined process, but underlying this is the fact that commercial and recreational fishers, the community as a whole and tangata moana all have an interest in protecting both the ecosystem balance and health but also kina as a taonga and important species in its own right.