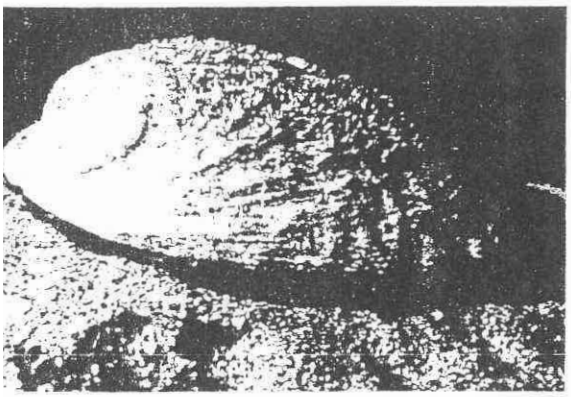
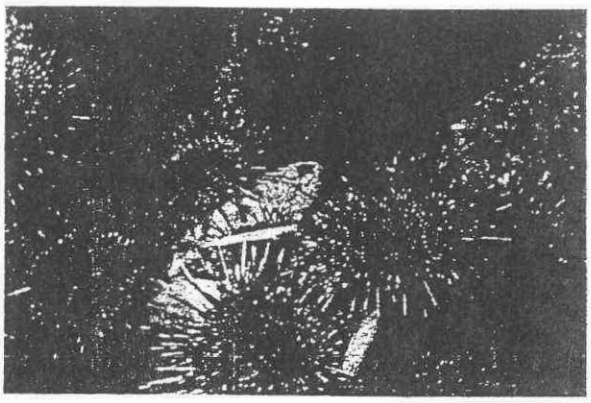
A Community Guide to Monitoring Paua and Kina Populations





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National Institute of Water & Atmospheric Research

For the Ministry of Fisheries

20 March 2002

Nga Mahi Te Taiao

ENVIRONMENT & NATURAL RESOURCES

Research Education Planning Development

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1. Why Monitor?

The state of kaimoana stocks in particular areas of customary or special usage is, at present, a pressing issue for most, if not all, coastal hapu and coastal communities generally. There are concerns about the apparent decline in number and size of most reef species available to meet day-to-day and special needs (e.g. tangi and hui). Paua and kina are prized kaimoana and their availability in part supports the mana of the local hapu and generally that of iwi by allowing tangata whenua to provide manaakitanga towards guests and visitors to their area.

Precise and reliable information about the state of these stocks, how they vary over time and how they compare to adjacent stocks, perhaps under some other management regime, is a powerful tool in making management decisions or persuading others that some management decision is necessary.

Within a community there is often a lot of anecdotal information about where paua and kina were fished, how many were taken and what methods were used to capture them. Some of this information may be in the form of fishing diaries, photographs or simply memories of the older members of the community. They are all valuable and help to define how things used to be. A well designed and established monitoring programme will compliment these other sources of information and will enable trends in the abundance or size composition of paua and kina populations to be determined. This manual documents sampling techniques that can be used to monitor kina and paua populations and generate the information necessary to promote the best informed management option and convince others that the reasoning and evidence is sound.

The techniques described are straight forward and within the capability of a well organised and motivated community. However, this is not to diminish the demands of the task. Working in or on the sea is never an easy task given the changeable weather, the bewildering array of species, the often poor underwater visibility and the difficulties and dangers of working underwater.

2. What is a Paua?

Paua (abalone) are marine molluscs. Molluscs have a spiral shell, muscular foot, and a rasping feeding organ (radula). Paua have a single, large, loosely coiled oval shell, with a row of holes along the back through which they expel water. The outside of the shell is often encrusted with marine life while the interior of the shell has shiny iridescent blue and green patterns. New Zealand has three species of paua: *Haliotis iris* (blackfoot paua), *H. australis* (yellowfoot paua) and *H. virginea* (whitefoot paua), but only *H. iris* and *H. australis* are commercially harvested. What follows generally applies to all species but focuses on the blackfoot paua.

Where are paua found?

Paua are shallow water inhabitants. They have a patchy distribution along the coastline and are generally located around wave-swept rocks in water less than 10 metres deep, although they can be found down to 18 metres depth. Adult and juvenile paua have different habitat requirements. Adult paua live in exposed sites on boulders and rocky ridges. Juvenile balckfoot paua (<70 mm shell length) are found in more sheltered sites, such as in crevices, cracks and under rocks and boulders. Some of these juveniles can be accessed at low spring tides.

How do paua feed?

Paua are herbivorous browsers. They scrape algae off the rocks using their radula, which is like a long flexible muscular-ribbon studded with tiny teeth. Adult paua also feed on pieces of drift seaweed. Paua are largely sedentary animals, only moving short distances at night to graze but over the course of a year some individuals may move 100 m. Paua move by contracting their foot muscles, causing a wave-like movement to sweep along the foot.

How do paua reproduce?

Female paua have a dark, usually green, gonad while male paua have a light, cream-coloured gonad but this can't be observed externally. Paua begin to produce mature eggs or sperm when around 60-80 mm shell length, by which time they are about 4 - 5 years of age. Spawning of eggs and sperm usually occurs in late summer or early autumn, and sometimes again in spring. Large female paua

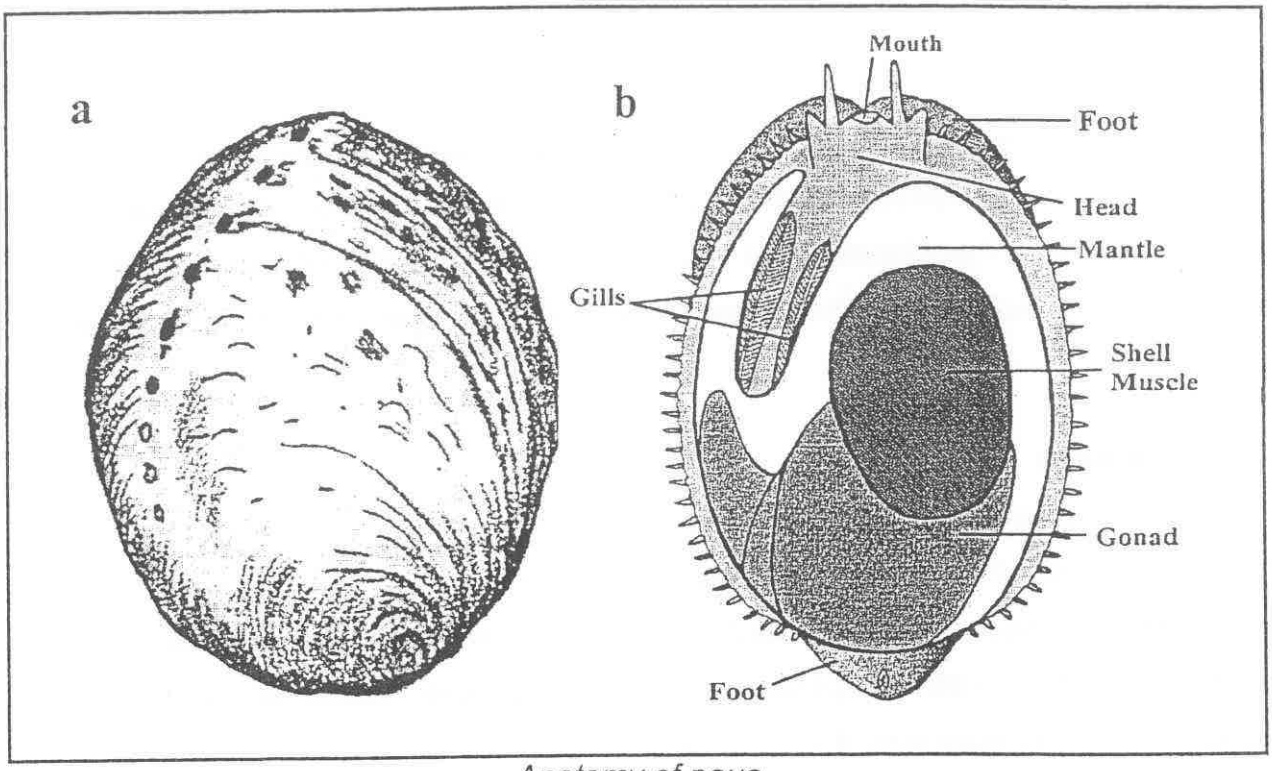
release millions of eggs into the water, which are then fertilised by sperm released by males at the same time. The fertilised eggs develop into larvae that float in the water for 7 - 15 days before settling onto rocks. Larvae detect the presence of favourable surfaces, such as those covered with pink coralline algae, and settle on these rocks. Wave exposure, currents and the shape and structure of the rocks can affect settlement. Paua larvae have a high death rate due to predators or failing to settle on a suitable surface. Only a few of the millions of eggs originally released will survive.

Growth of paua

Paua grow at a rate of about 10 to 20 mm every year. Once paua reach about 140 mm shell length, their growth rate slows. However, growth rates of paua vary considerably between populations depending on local environmental conditions such as food availability, water temperature and wave exposure. Blackfoot paua *(H. iris)* can grow to a maximum size of 200 mm shell length.

What can adversely affect paua populations?

Like most animals, paua are not an inexhaustible resource. Over-harvesting, damage caused by inappropriate fishing techniques, predation, and pollution are all factors that can adversely affect paua populations. Predators of paua include starfish, rock lobster, reef fish (blue cod, snapper and parrotfish) and, of course, people.



Anatomy of paua

a) external view of a paua shell, and b) the same view with the shell removed

Box 1.	A video of paua natural history

If you want to learn more about paua biology and behaviour then a short video "The Magic of Paua" produced by Mr Chris Thomas of NIWA is available at a reasonable price. It comes in 9 minute version or a 25 minute version. The video contains some unique footage of the paua life cycle, including feeding, spawning, predation and larval behaviour as well as harvesting underwater and processing of the meat and shell. Contact Chris Thomas at NIWA PO Box 14-901, Kilbirnie Wellington.

Ph: 04 386 0300 Fax: 04 386 0574 email: c.thomas@niwa.cri.nz

3. What is a Kina?

Kina (*Evechinus chloroticus*) are sea urchins or sea eggs. These creatures are well known around the coast of New Zealand because of their distinctive characteristics including a hard spherical green/brown shell (test) with long moveable spines. Many other sea urchins occurs in New Zealand but kina is the most common inshore species. They are related to star fish, brittle or snake stars, feather stars and sea cucumbers in the phylum Echinodermata.

Where are kina found?

Kina are a dominant animal in many sub-tidal areas around New Zealand, and are often associated with dense areas of seaweed. Kina are found on both firm and soft bottom surfaces, in exposed and sheltered habitats. Juvenile kina can be found in the inter-tidal zone under rocks, in small crevices, and in depressions in rocks but also occur at greater depths. Kina can occur in very high densities in some areas (up to 50 per square metre).

How do kina feed?

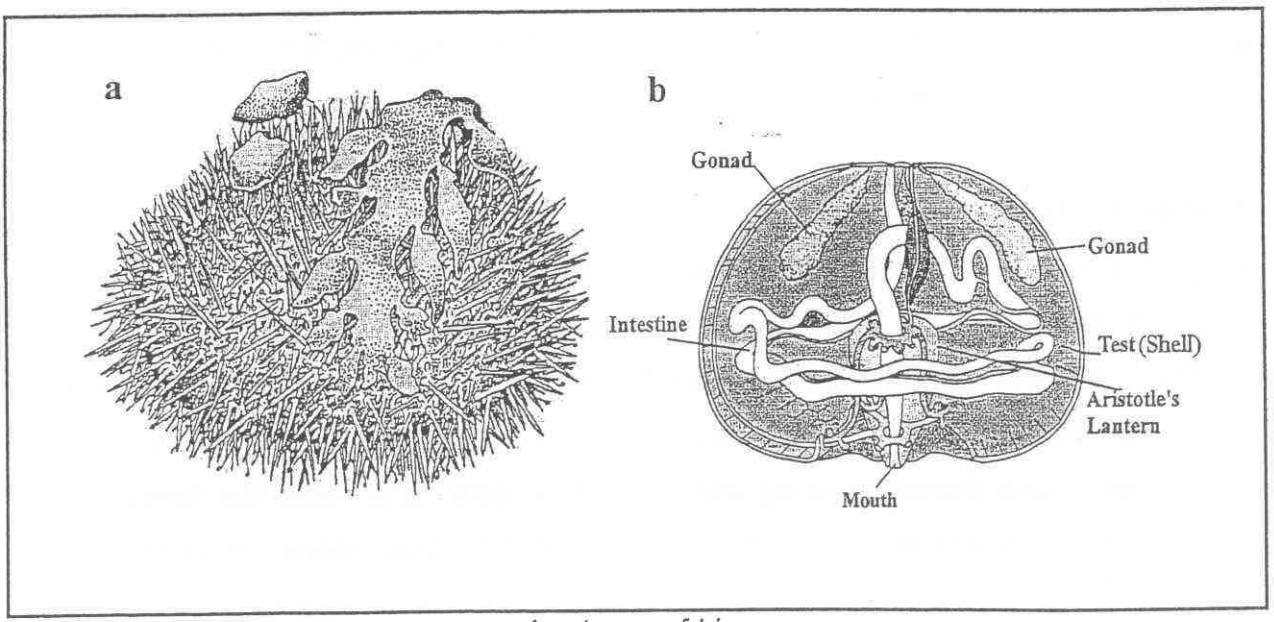
Kina have a special feeding organ called an Aristotle's lantern (found inside the shell, near the mouth). This scraping apparatus allows them to graze algae off rock surfaces, with the spines helping to capture seaweed fragments floating in the water. Kina also eat other marine organisms they come across, such as sponges and sea anemones. Kina move by using their spines to push and raise the bottom shell surface off the substrate (like stilts). The distance they move depends on the amount of food available. If there is a lot of food in one spot, kina will stay there until it is gone.

How do kina reproduce?

Kina have five gonads suspended on the inside of the shell. These are the yellowish-brown, spongy looking organs that produce eggs and sperm (this is the part we eat, also called roe). Eggs and sperm are released into the water via a hole at the top of the shell. Fertilisation takes place in the water, with the fertilised eggs developing into larvae. The larvae settle after about 4-5 weeks of floating in the sea,

when they are about 0.5 mm in diameter. The long larval stage plays an important role in the dispersal of juveniles away from the spawning area. Juveniles will settle on all types of surface but mainly in a sheltered area, such as under rocks or in crevices. They remain in these areas until they grow to about 20 mm test diameter and their spines are developed. Kina grow 10 - 20 mm every year until they reach sexual maturity. The age at sexual maturity varies between populations, but generally occurs between 3-4 years (40 – 70 mm). Growth rate is affected by exposure and food availability. The numbers of sperm and eggs produced by kina decreases with age; very large kina are reproductively inactive.

Predators of kina include rock lobsters, reef fish (blue cod, red moki, snapper) and sometimes shellfish (such as trumpet shells) and starfish. Humans can affect kina populations by over-harvesting and pollution. Like other valued resources, care must be taken to ensure the long-term availability of kina.



Anatomy of kina

a) external view of a kina, and b) interior view of a kina (as if it has been cut in half)

4. New Zealand Fisheries for Paua and Kina

Customary Fisheries

Fishing for paua and kina was carried out in New Zealand long before any commercial fishery was established (pre-European times). Both species have always been highly valued by Mäori communities. Paua flesh was an important component of traditional diets and the shell used for decorating carvings and adornments. Kina are harvested for their roe. Both species were gathered by hand at low tide or by free-diving in shallow water. Local communities employed traditional management techniques to ensure sustainability. This included restrictions on the areas where paua and kina could be taken from and taking only the amount needed. This information was passed on from generation to generation. Paua and kina still play an important role in Mäori culture, especially in manaakitanga ki nga manuhiri (the hosting of visitors).

The regulations covering customary fishing are complex, differ between North and South Islands and in some cases are still under development. Check the Ministry of Fisheries web site at http://www.fish.govt.nz/customary/index.html to obtain the latest information.

Recreational Fisheries

Recreational fishing for paua has become an important part of the New Zealand lifestyle and makes up a significant proportion of the total harvest each year. Concern for the sustainability of paua, due to an increase in fishing pressure, has lead to the development of a code of practice for amateur paua divers and hand-gatherers (available from the Ministry of Fisheries). The recreational fishery is managed by bag limits and size restrictions. These limits are described in detail on the Ministry of Fisheries web pages (see http://www.fish.govt.nz/). In brief these regulations state that no person may daily gather more than 10 paua of either the normal blackfoot or yellowfoot species. The minimum shell length for blackfoot is 125 mm and yellowfoot is 80 mm and, as with the commercial fishery, the use of underwater breathing apparatus (SCUBA) is not permitted when harvesting paua. Paua also needed to be landed whole in the shell.

The recreational fishery for kina is managed by a daily bag limit of 50 per person. There is no minimum size restriction. The recreational fishery for kina is small compared to that of other shellfish.

Commercial Fisheries

The commercial paua fishery began in the mid-1940s. Paua were initially harvested for the shell, which was used to produce jewellery and souvenirs; the meat was discarded by most fishers. It was not until the 1960s that the meat began to be marketed in New Zealand and overseas, and since then there has been rapid development of the market. The commercial fishery is predominantly comprised of blackfoot paua but does include a small proportion of yellowfoot paua.

The commercial fishery for kina is relatively new and small compared to some other shellfish fisheries. The harvests are sold mainly on the domestic market although an international market is being developed. The variable quality of the roe hinders the establishment of an export market. Sea urchin roe is of high value in some countries, especially Japan, but the quality must be high, and factors such as colour, taste and texture are important. The diet and age of kina, as well as the state of the gonads at the time of harvest, can affect taste and texture.

The commercial fisheries for paua and kina are managed under the Individual Transferable Quota (ITQ) system. The commercial quota able to be caught each year within a number of quota management areas (QMA's) around New Zealand is set through an exhaustive process which starts with the "Shellfish Stock Assessment Working Group". This group comprises Ministry of Fisheries officials, fisheries scientists and representatives of the rock lobster fishing industry, recreational fishers, Maori and conservation groups. This is an open process that any individual or group can attend if they have something factual to contribute to the stock assessment process. This is not a venue for discussion or argument about allocation. Contact the convenor of the Shellfish Stock Assessment Working Group at the Ministry of Fisheries in Wellington if you wish to participate. The working group holds a series of meetings in Wellington starting in January to determine the present state of the stocks and how much should be set aside for commercial fishing. To do

this, estimates are first made of recreational, customary and illegal catch in each QMA but often these are poorly known. If you have information that would help decide these levels then the working group will be happy to see your evidence or hear from you in person. Much of the discussion tends to be highly technical but don't let this put you off.

The stock assessment process culminates in a plenary session each May where the evidence and conclusions are presented to a wide group of stakeholders. Discussion is encouraged. This information is ultimately presented to the Minister of Fisheries who then makes the final decision regarding allocation of commercial quota.

Box 2. Obtaining permits

If your assessment methods means that you will be catching and handling undersize paua, more than the legal limit for paua and kina, or if you are planning to use SCUBA to collect paua then you may need to obtain a Customary Fishing Authorisation or a special research permit from the Ministry of Fisheries. They will inform you of the specific information required for the applications but generally you will need to include:

- Why the sampling is taking place
- The date sampling is to take place
- Who will be doing the sampling
- The area sampling is to take place
- The number of paua and kina to be taken
- The method to be used (e.g. SCUBA)
- Any other conditions (e.g. that any paua or kina collected be returned to the water)

It is important to emphasise to all participants in the programme that if the work is being conducted using a special permit **no paua or kina can be collected**, they must all be returned to the water. The days you choose to carry out your sampling must be strictly confined to collecting data for the monitoring programme; harvesting must be left until another day. Ring your local Compliance Office of the Ministry of Fisheries in advance and let them know when and where you are planning to sample. Also, if you are sampling in a public site, where other recreational beach users may be present, it is a good idea to put signs up on the beach indicating that a survey is in progress. This should avoid people getting the wrong impression when seeing divers in known paua or kina areas.

5. How does a Monitoring Programme Work?

It is usually impossible to survey an entire area, or count every individual animal; therefore we take samples of the population which are representative (typical) of the whole population. A one-off survey of paua and kina stocks in an area using this sampling approach will enable you to estimate their abundance and size composition. By repeating this survey on a regular basis questions about whether the stocks are declining or increasing in abundance can also be answered. This information alone will not tell you the reason for the change; you won't know whether it is your management that is having an effect, or whether the fishery as a whole is improving.

If you need to know why your population is changing it is important to also collect comparable information at control sites from outside the area of direct concern. Doing this will enable you to distinguish between the impact of any local management decision and regional trends in the abundance of paua and kina. For instance, imagine you introduced a rahui or closure for paua within part of a taiapure, carried out a number of annual surveys within this area only and found an increasing trend in paua abundance. However, unbeknown to you, natural events meant that generally within the larger region very high settlement of paua larvae resulted in increasing abundance of paua. Because you did not sample outside the rahui area you could not distinguish between the effects of your management actions and the natural increase in abundance. In these circumstance you might incorrectly conclude that the rahui had a great effect where-in-fact most of the increase may have occurred naturally.

As a rule of thumb plan to collect at least half your information outside the area of specific concern. It is better to have numerous "control" sites rather than just one, but take care that they have similar habitat or bottom type as the your area of principal concern. If there is an area of zero exploitation (eg. a marine reserve or cableway) in your general area then you may gain permission from the Department of Conservation to sample in this area as well. Doing this could indicate what the population response in your area might be when the effects of fishing are removed.

6. Objectives of your Monitoring Programme

This is the most crucial part of your programme as it defines how and what you do and why you want to do it. You must establish very clearly what question or questions your monitoring programme is going to answer.

- Is it to determine year by year the abundance and average size of the legal sized population so that you can tell if there is an increasing or decreasing trend?
- If this is the case then estimates of density and size frequency at key sites might be adequate.
- If you also want to know if these trends are different to those occurring in the general regional area then similar areas nearby will also need to be sampled.
- Alternatively, is your objective to determine the overall number and weight of paua or kina in your area so that you know what proportion might be available for recreational and customary use?
- If this is the case then you will need to use a method like diver counts that yields estimates of actual abundance per unit area of reef and in addition have a good estimate of the area of suitable reef or habitat for paua and/or kina.

Establishing year by year fluctuations in abundance and size is the most basic part of a population monitoring programme and all other questions merely build or expand upon it. If this part of the monitoring programme is planned and achieved well then a very useful body of information will build up.

Part of the process of defining your questions is to also define the area or population of interest.

- Is it the population within the whole or just part of a taiapure for instance?
- Are kina on reefs at all depths of interest or are you only interested in those within the shallow subtidal depths (less than 10m or 30 feet water depth)?

As time, energy and need arise then additional questions could be addressed.

- Perhaps trends in the juvenile paua and kina under rocks will also be of interest as they will indicate the numbers entering the fishery in the next year or two.

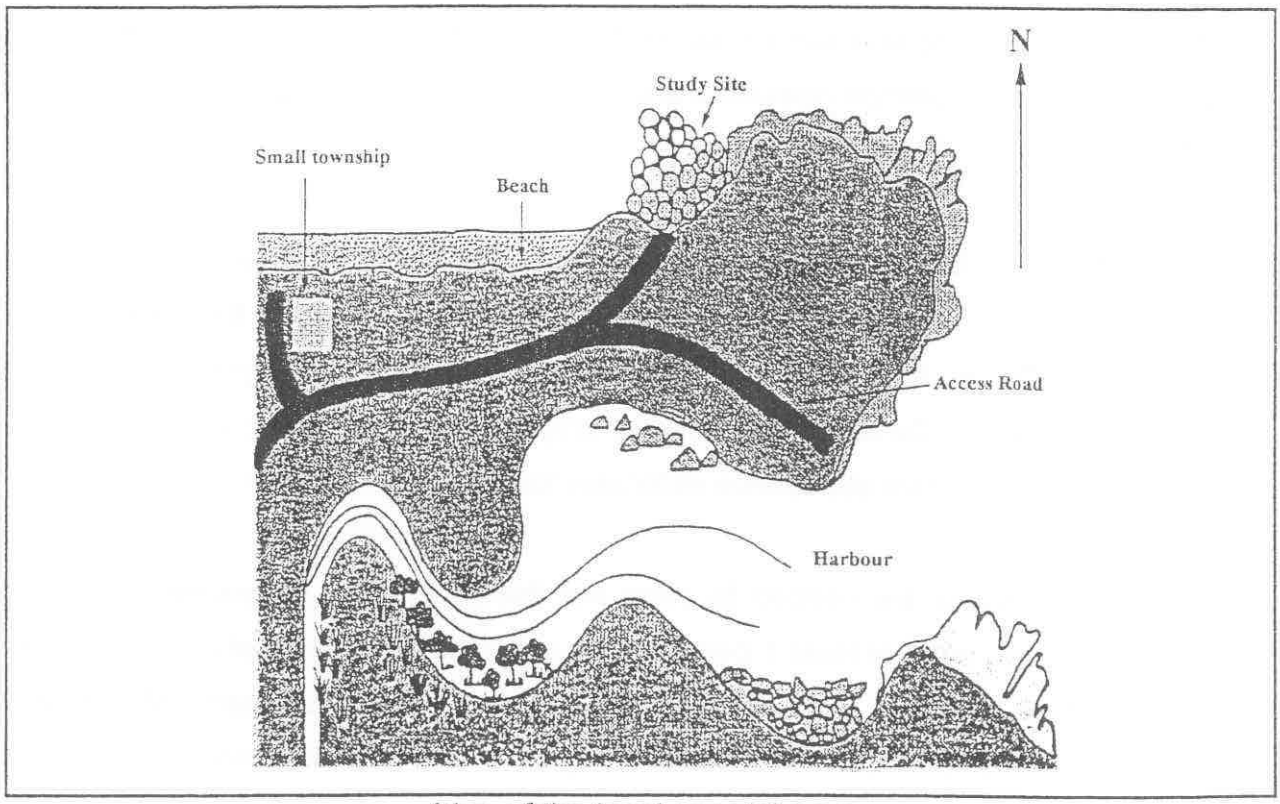
- Do growth rates need to be determined for one or two years as this will help tell you if the paua will ever reach legal size in your area and how fast the population biomass or weight will increase if more or fewer paua or kina were fished?

Make sure you allow enough time and discussion to establish your objectives and ensure they are clearly recorded well before the monitoring programme starts. You may wish to bring in some external help from a professional scientist at this stage.

7. Getting Started

Getting to know your coastline

You may already have an idea of the distribution of paua or kina along the coastline in your region. It is useful to obtain a map of your coastline, marking on it areas of particular importance. For example, high harvest areas, popular fishing spots, river entry points, point sources for pollution and the types of land use that occur around your coastline (e.g. farming or forestry). A map provides a useful visual representation of your coastline and will help you to brief the sampling team and people who are not familiar with your area. In addition, after you have collected your data, you can use this map to illustrate the density of shellfish at certain areas of the coastline. You may be able to obtain an aerial photograph of your study area. If this is taken at low tide on a day with no swell and good underwater visibility you may be able to distinguish areas of different underwater bottom type to depths of about 10 m. Contact an aerial photographic company to do this for you. You may need to have a standing order with then to do a fly over and obtain the shots when conditions are perfect. Alternatively, your regional council or Land Information New Zealand or Terralink may already have such photographs in their files. Try them first.



Map of the local coastal area

Getting your community involved

There are several groups of people who you may want/need to contact before getting started. These include people from local hapu, iwi, recreational fishers, local residents, regional council representatives, fisheries representatives and local businesses (sponsorship). Also, talk to the people in your community who you know are interested in the health of shellfish stocks. These people may be interested in helping out on the sampling days. It is a good idea to find someone who is good with numbers, or owns a computer, to collate and present the data in a graphical form. The survey methods used in this monitoring programme are carried out using SCUBA. Therefore, you need at least two experienced divers. If you do not have experienced divers in your community you may be able to get help from members of local dive clubs or other organisations that work in the marine environment (e.g. Universities). Don't forget to contact the tangata whenua in your area at the very start of the planning process and invite them to join. They have a stake in the health of the local kaimoana, will be able to give some positive input into your project and may be able to provide useful historical information.

In some communities you may need to be a bit more proactive/inventive to get people involved in your project. Be equipped with information to convince people of the positive benefits that can be gained from establishing a monitoring programme. Below is a list of common questions and answers to give you a general idea of types of issues you may be queried about.

How often do surveys need to be completed? Estimates of abundance and size-class frequency distribution should be conducted every year, at the same time of year, if possible. If support and resources are limited then you may wish to concentrate your efforts on reef-fish and crayfish one year and paua and kina the next so that you obtain abundance estimates for each species every second year.

How many people are needed to carry out this monitoring programme? On each survey day you need at least 1 person to co-ordinate the survey, at least two divers, a boat driver and other general helpers for support. Ideally two teams of two divers should work out of each boat so that one pair is in the water throughout the day. Better still arrange for several boats to be used each with a team of four divers so

that you take maximum advantage of good weather. Once the survey is finished you may need someone to collate all the data and write a report.

Do the same people need to do the sampling each year? It is ideal, but not always practical, to use the same people from year to year. The main co-ordinator of the project should be someone who is likely to be in the community for a few years. This person can then pass on all the information and teach the techniques to newcomers.

How long will it take? This will depend on the number of samples, the number of people involved, the diving depth and the weather conditions during the survey. Conducting a preliminary trial will give you an idea of the time involved in sampling. There are no decompression limits of 35 minutes at 21 m depth. Typically deeper sites take 20-40 minutes depending on the number of paua and kina and the amount of seaweed to search through. Shallow sites generally take longer to search due to the rough terrain, thick seaweed and strong wave surge.

What will it cost? There will be some initial costs involved in getting started but, once equipment has been bought or made for the first survey, ongoing costs will be very low. The ongoing cost will mainly be related to the production and photocopying of data sheets, filling dive tanks, and boat fuel (if using an outboard).

8. Special Equipment Required

Quadrat

A quadrat is a simple instrument used to mark out an area in which to determine the abundance and distribution of organisms. It is simply a square frame that marks out one sampling unit. For this study we will use a 1 metre by 1 metre quadrat ($1m^2$). Quadrats are easy to make with a piece of nylon or rope about 5 metres long. Thread four metal sinkers along the rope at 1m intervals, and then tie a small knot on either side of each sinker before tying the ends together. The quadrat can then be laid out in a square with the sinkers at each corner (See page 16). Remember, the quadrat has to be heavy enough so that the surge does not move it around. Traditional quadrats are fixed structures made of steel, but they would be too cumbersome to use in relatively shallow water. Your quadrat will be easy to manipulate in the water and manoeuvrable around seaweed and rocks.

Transect

This is a 40 metre reel of non-corroding material, such as dacron or nylon, marked at regular intervals (5 metres) along the line. Depending on the type of material you use for your line, you may have to attach lead weights to keep it sitting on the bottom, unaffected by the surge. It is best to have your line on a spool to make it easy to lay out, and to keep it from becoming tangled. Alternatively, a 50 m fibreglass tape marked in metres on both sides can be used. One is provided in the field kit.

Length measuring device

This device is used to measure the length of paua or diameter of kina to get information on size-class frequencies. The best measuring device is a pair of stainless steel calipers available from some engineering companies. These vary in price from $50 - $90 depending on brand and quality. Plastic callipers are also satisfactory and are much cheaper ($2 - $5 each) and are available from hardware stores. Alternatively, you may be able to borrow calipers from the Ministry of Fisheries, but it is a good idea to invest in some for your programme. You will need

one pair for each diver. Attach the callipers to the slate board with a piece of cord to avoid losing them.

When measuring paua or kina, we are aiming to minimise the time spent under water, harm to the animals, and damage to the habitat. Paua can be measured while still attached to the rock, but the most efficient method is to remove them from the rock using a specially blunted knife or trowel and place them in a catch-bag for measurement back on the boat or beach. Paua are measured in a straight line along the longest part of the shell. Once measured and/or tagged carefully return individuals to the rock surface (the right way up).

Kina have to be removed for measuring, but they are relatively easy to pick up. It is a good idea to wear a glove on the hand holding the kina, as the spines are very sharp. Kina are measured across the diameter of the test (shell) excluding the spines (See page 16). For kina, it is easiest if you turn them upside down and measure across the widest part of the test.

Juvenile paua and kina are hidden in the crevices and under rocks, so they will not be included in the main survey. If juveniles are of special interest an additional survey targeting crevices and the underside of boulders will need to be carried out. The basic sampling unit for this survey may be a 1 m x 1 m quadrat.

Catch bags are available from sports or dive shops in various shapes and sizes (around $70). They are usually made of mesh nylon, so they drain quickly, with a wire frame to hold the top open or closed. Most have a locking device to secure them in a closed position. You could make your own using an onion bag and a wire hoop.

Underwater record keeping material

Due to the environment that you will be working in, some special equipment will be needed to record the information that you gather. You will have to count and measure every paua or kina in the quadrat or along the transect line. This information has to be recorded whilst underwater. There are a few alternatives to choose from.

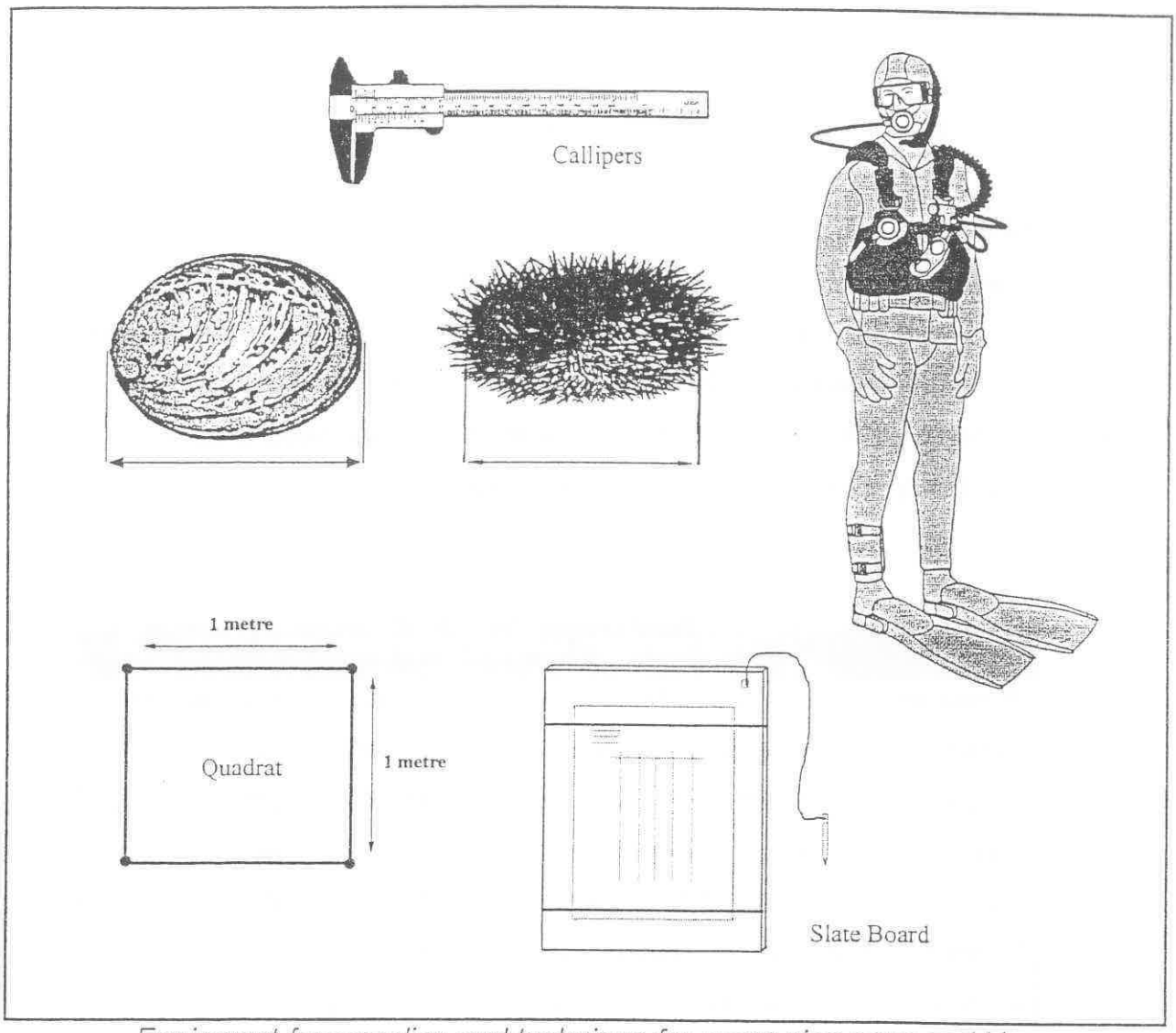
- *Plastic Slate Boards.* It is easy to make your own from PVC plastic. Visit a plastic product company (e.g. Progressive Plastics Ltd., Dunedin) and ask for off-cuts of PVC plastic between A4 and A5 size. This should only cost a few dollars. Drill a hole in one corner to attach a piece of cord to tie your pencil on. You can write directly onto the plastic board with a pencil. However, if you choose to do this, the data must be transferred to paper data sheets each time the board is filled. It can be cleaned with household cleaning fluid or the pencil marks rubbed off with an eraser.

- *Underwater Paper.* Special underwater paper is available from most paper suppliers or printing companies at around $6 - $7 for 20 A4 pages. Attach this paper onto the slate board with rubber bands or clips at the top and bottom. Have it ruled up into the appropriate columns in advance. Note: this paper cannot be used in a photocopier. Only one type (Xeroperm Lazerprint 3R 96094) can be used in a photocopier to print up the sheets with headings and columns etc. If any other type is used it will melt inside the copier!!

- *Pencils.* Regular HB pencils can be used to write on the underwater paper or slate board. Pencils should be attached to the slate by string or cord. Drill a hole in the end of the pencil and tie to the piece of string attached to the slate board. Fasten the knot with insulation tape. Keep a spare pencil in one of your BC pockets.

Global Positioning System (GPS)

A handheld GPS is invaluable in determining exactly where the samples came from. This information should be recorded on the data sheets and on the map or chart. A handheld GPS is not expensive and will accurately determine the sample position to within a few metres.



Equipment for sampling and technique for measuring paua and kina

Programme log book

It is useful to keep a logbook for your monitoring programme. This way useful information can be kept in one place and passed on to future organisers, if necessary. The type of information that is useful to record is: equipment costs, suppliers and contact details, details from meetings, a record of events leading up to and including the sampling day (e.g. quadrat and transect positions), phone numbers of volunteers, and sketches of the study area.

Tagging Paua

If you wish to determine annual growth rates of individual paua then they need to be uniquely identified so they can be recaptured and re-measured. Small round alphanumeric tags suitable for identifying paua a year or more after release are

available from a few specialist suppliers around the world (see Appendix E). They come in rolls of 1000. You will also need glue to attach the tags to the shell. Experience shows that Selly's Superglue works best.

Using a boat?

If you want to look at the abundance of paua/kina on reefs that are offshore or far from the access point, you may need to use a small boat. If you decide to use a boat, remember to factor in the additional cost of fuel and boat maintenance. Also, you will need an extra person to drive the boat and you will need to consider the additional safety issues associated with boat use.

Box 3	Hot sunlight quickly kills paua and kina
If you are measuring any marine creature on board a boat and then returning it to the sea ensure you have adequate shade. Paua and kina will quickly overheat if they are exposed to strong summer sun for any length of time. This will kill them or greatly reduce their chances of survival after their return to the water. If you had brought the paua on board for tagging and measuring as part of a recapture programme it is in your best interests to reduce stress on the paua as much as possible. Working in the shade is less stressful for the team on board the boat as well!	

9. Equipment Checklist

Go through this list on the day to make sure you have everything before you set out to the beach. Each person will have slightly different requirements depending on their role in the programme.

Group Gear (this gear is best kept with the main organiser of the programme)

- ✓ First Aid Kit
- ✓ Mobile phone or radio (for safety and coordination)
- ✓ Log book
- ✓ Tide tables & weather report
- ✓ Copy of permit
- ✓ Study area markers (e.g. flags on stakes)

Boat Gear (per boat)

- ✓ Mobile phone or radio (for safety and coordination)
- ✓ Log book (for logging dive times)
- ✓ Tide tables & weather report
- ✓ Copy of permit
- ✓ Appropriate safety equipment (life jackets, flares etc)
- ✓ GPS for accurate recording of sample location

Scientific Gear (per Diver)

- ✓ Calipers (measuring device)
- ✓ Quadrat , tape measure & 1 metre rod
- ✓ Diver catch bag
- ✓ Trowel (for removing paua from rocks)
- ✓ Slate board with pencil attached + spare pencils and data sheets
- ✓ Compass

Personal Gear

- ✓ Towel
- ✓ Warm clothing
- ✓ Food and drink (hot and cold)
- ✓ SCUBA and snorkel gear, dive gloves & spare tanks
- ✓ Sunblock, sunglasses and sunhat

10. When to Sample

One of the major factors that will determine when you carry out your main sampling event is the weather. The weather can affect visibility and wave exposure. Ideally, you want high underwater visibility and low wave exposure to make sampling as easy as possible and less time consuming. Have a back-up date in mind in case the weather conditions change.

The time of year (season) is also an important factor to take into consideration. This may be particularly relevant to those conducting surveys in the far south of New Zealand where water temperature may be an important factor in determining when you will sample. The warmer the water temperature the more comfortable conditions will be to work in and divers will be able to stay in the water longer and collect more information on shellfish stocks.

The time taken to complete the sampling event will depend on the number of samples, the sampling conditions and the number of divers. Ideally, it should be done over a short period of time (1 – 2 days). Sampling should be carried out at the same time of year in future years.

The tides will also influence when you will carry out sampling. Whether you sample at low or high tide will depend on the topography of your sample site. If you are sampling close in to shore it may be easier to wait until high tide. This may stop the surge from shifting the divers around too much.

Planning when to sample is one of the most important factors in successfully carrying out your survey. As you can imagine, it is often difficult to get all the factors listed above at their optimum at the same time (fine weather, low swell/surge, high visibility, tides at a convenient time of day and availability of volunteers).

11. Pre-survey Preparation

Establishing a sampling team

You should by now have a group of people who are going to participate in the monitoring programme. The number of people involved will vary between programmes and will depend on factors such as the size of the area to be surveyed. However, a minimum number is required to ensure the work can be done safely in 1 – 2 days. Establish the responsibilities of each person so everyone is 100% sure of their role in the programme.

- Principal Organiser – This person is probably the one who instigated the monitoring programme and their role is generally to oversee the whole project. Specifically, this person will be organising equipment and sampling times, and recruiting volunteers, or at least delegating these tasks to others. On the sampling day the role of the principal organiser is to ensure everything runs smoothly.
- Boat drivers – in many cases the survey will be conducted from boats and hence rely on experienced boat drivers. There should be one other person on board each boat who knows how to operate the boat equipment , start the engines and drive the boat in case the driver becomes incapacitated.
- Divers – at least two experienced divers are required.
- Data Collectors – these people are responsible for collecting the data from the divers and copying it onto a permanent data source (if it has been recorded directly onto the slate board), or giving the divers more paper when required.
- Support Crew – some people are needed onshore to be available to assist when the divers finish sampling. The support crew can provide the divers and data collectors with hot drinks, food, and dry clothing.
- Data Analyst – this person is responsible for collating the data.
- Extras – photographer, representatives from other organisations (e.g. regional council).

Pre-survey meeting

Before the main sampling event, arrange a time to meet with the people who will be involved in the monitoring programme. If the weather is fine this meeting can take place at the study site.

Checklist of objectives for pre-survey meeting:

- Discuss the objectives of the survey with the sampling team.
- Ensure participants are familiar with the study site.
- Go over the methods to be used in the survey. The divers should be familiar with the techniques of measuring and counting paua and kina. It is a good idea to practise measuring on old shells. This will give consistency in the data that is collected.
- Check all the equipment is functional (e.g. is the quadrat heavy enough?).
- Try to foresee any other equipment requirements or potential hazards and discuss safety issues.
- Go for a snorkel in the survey area to determine where the paua or kina are distributed. This is critical for the positioning of transects in your study area. Remember paua and kina have patchy distribution, so it is important to find exactly where they are so you survey the right areas. Look at the differences in distribution within your survey area. Are paua more abundant in certain habitats (e.g. flat, rocky, uneven and sandy) or certain depths (e.g. shallow, mid and deep water)? Define the areas of paua habitat and draw a sketch of their distribution.
- Practise counting and measuring paua or kina in a couple of quadrats and record how long it takes (this will help assess the time needed for the main survey).

12. The Sampling Method

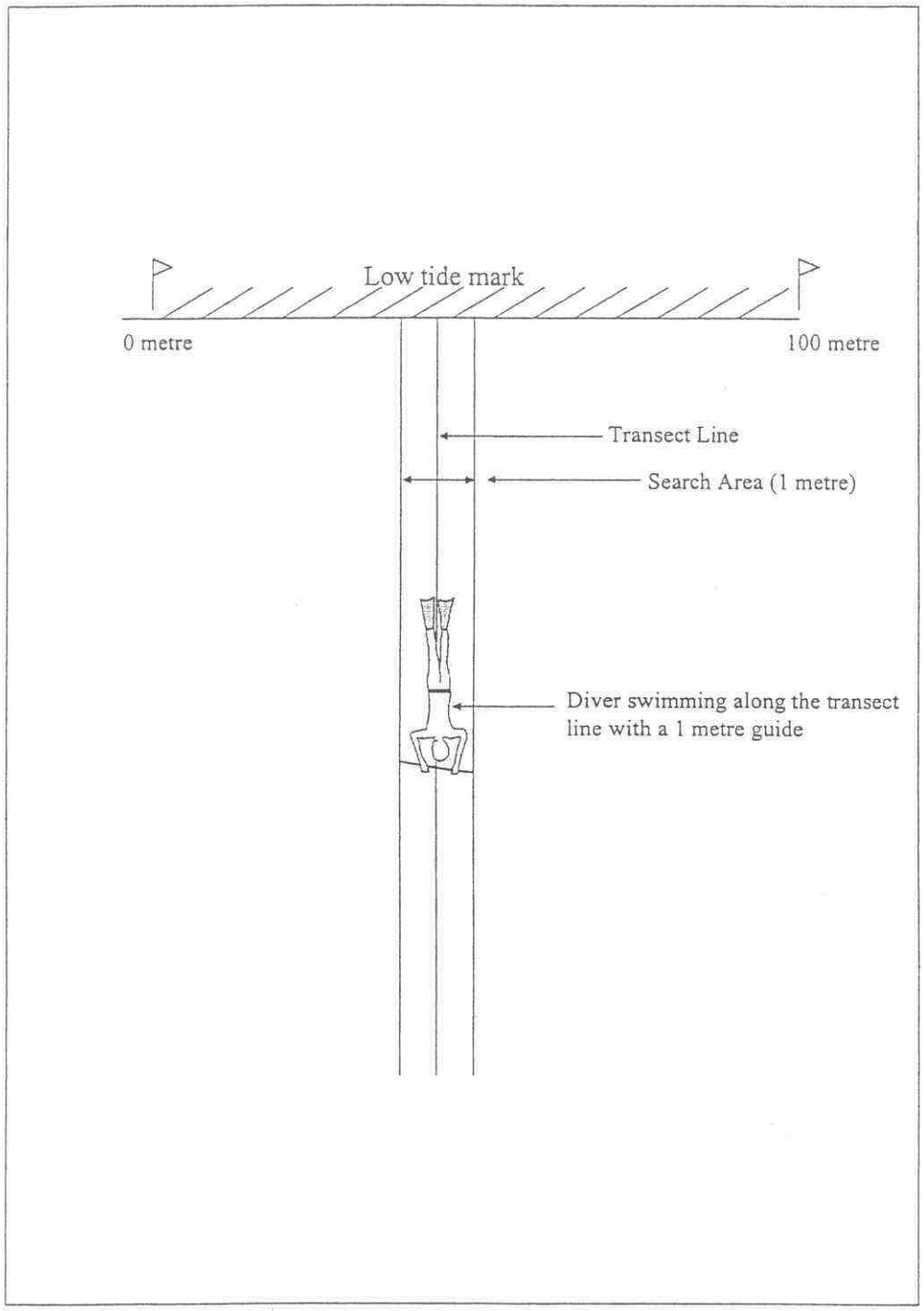
In order to estimate the abundance of shellfish we need to count the number of individuals in a small part of the population. Because every section of coastline is different, individual programmes will differ slightly in their set-up. Remember to be flexible and realistic when designing your programme. Tailor your programme to maximise the amount of data collected for the labour you have available.

Transect survey

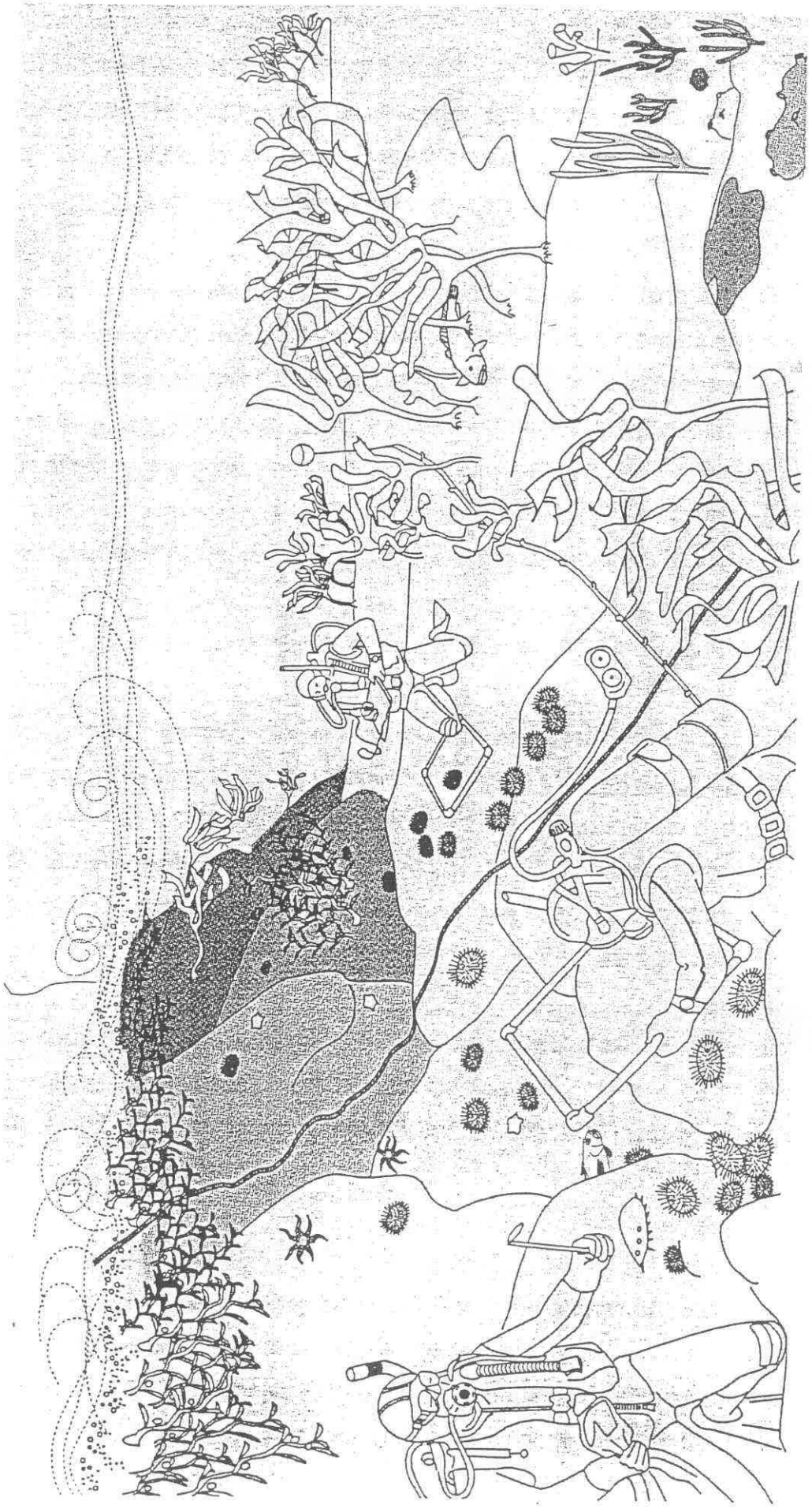
In this method divers count paua/kina in a defined area. The area is marked by a transect line and animals within a certain distance of the line (e.g. 0.5 m on either side) are counted.

- Within your study site area, lay the weighted transect line or fibreglass tape from the low tide mark away from, and straight out from, the shore or in a predetermined compass direction. If there is significant swell you will need to work from a boat and may not be able to get into the very shallow water. In this case start your transect in the shallowest area you can and note this depth on your slate. The transect line can be laid by people using snorkel while the divers get their SCUBA equipment ready. The length of the transect line will depend on the topography of the coastline. The transect line should extend offshore as far as you find paua/kina. However, if the slope of the reef is gradual your transect line will be very long (>50m) and difficult to manage logistically. In this case you could break your area into a shallow inshore half and a deeper offshore half that you sample with different transects. Make sure you put half your transects in the shallow and half in the deep areas.
- Swim along the transect line with a guide (e.g. 1 metre length of wire) held at right angles to the line.
- Count and measure (nearest mm) all paua/kina within 0.5 m of either side of the transect line. Record the length of the animals on the slate board.
- Repeat the transect line several times at regular intervals along the beach within your study area (e.g. every 25 metres). The number of transects will depend on the abundance of paua or kina in the study area, and the amount of time it takes

to count and measure all the animals within the transect area. There should be at least 5 or 6 transect lines, but more if abundance of paua or kina is low.

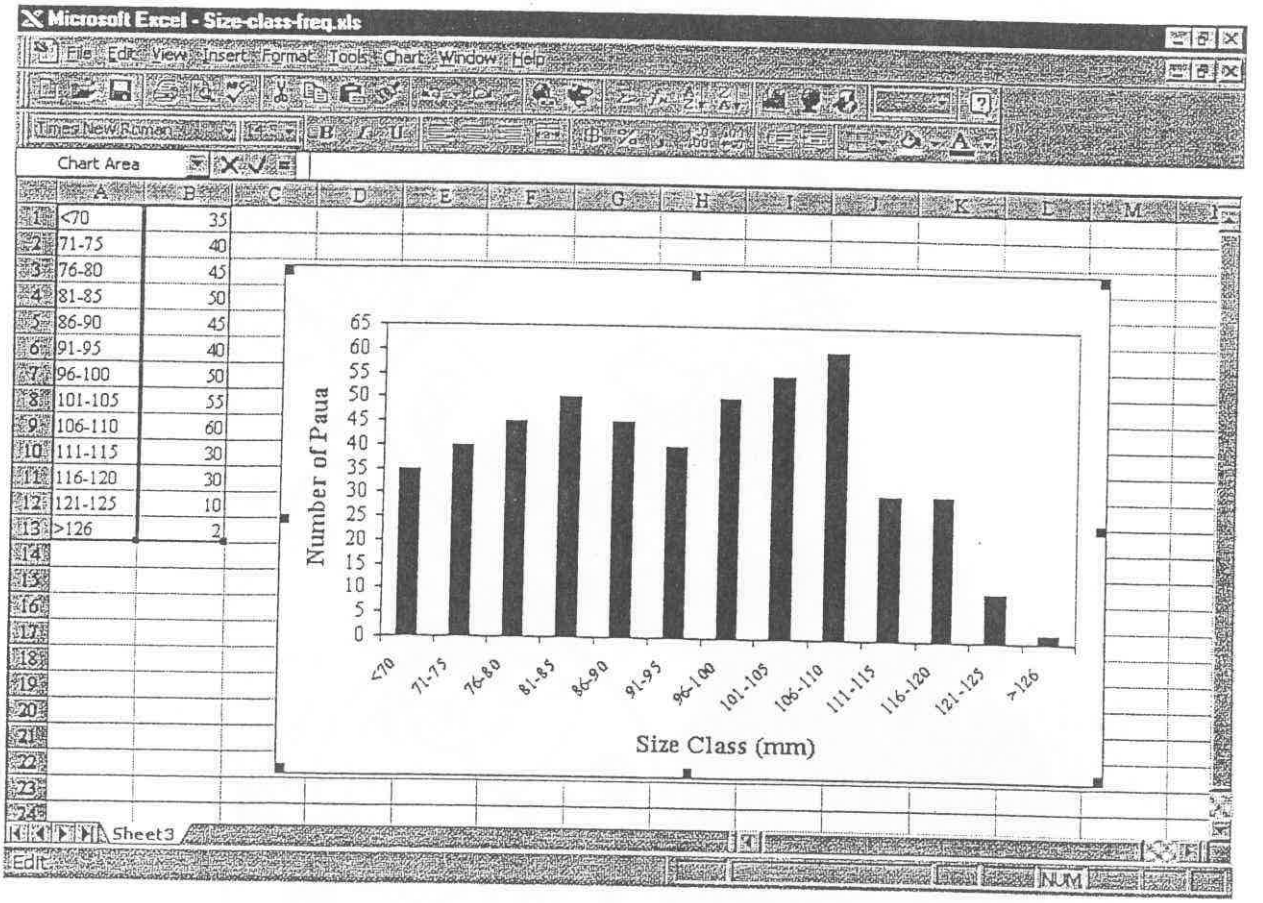


Example of transect survey method



this survey (too hard to find) the results cannot tell you about patterns of juvenile recruitment into the population.

These types of graphs are easy to draw by hand on graph paper. Or, if you have a computer available, you can do it in a computer programme such as Microsoft® Excel. Below is an example of how to enter data onto a spreadsheet in order to obtain a size-class frequency graph.



	A	B
1	<70	35
2	71-75	40
3	76-80	45
4	81-85	50
5	86-90	45
6	91-95	40
7	96-100	50
8	101-105	55
9	106-110	60
10	111-115	30
11	116-120	30
12	121-125	10
13	>126	2

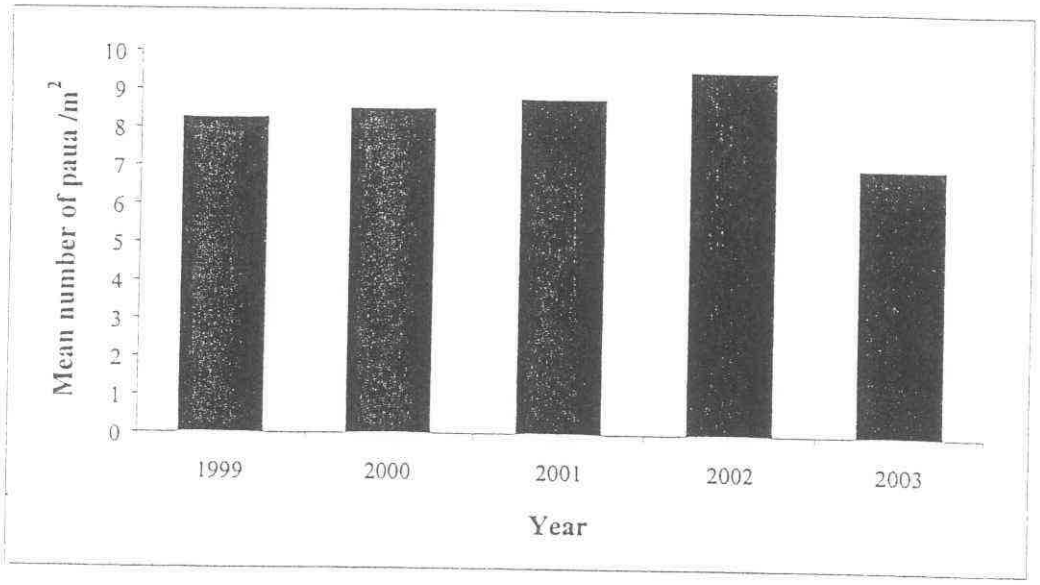
15. Interpretation of the Results from your Survey

What to do with your result?

1) Firstly, you may want to add the abundance information to the map or sketch of your survey area. Draw the symbols shown below onto your map to build up a visual picture of your paua/kina stocks. This provides some general information from a quick glance and is a useful tool for showing people the outcome of your monitoring programme.

○	Absent (0 paua)
•	Low (0 – 2 paua per square metre)
•	Medium (3 – 5 paua per square metre)
•	High (5 – 9 paua per square metre)
•	Very High (> 10 paua per square

2) Secondly, for your own reference, you may want to add the paua/kina density information to a graph so you can see changes from year to year.



In this case the abundance of paua appears to be very stable and is not changing much from year to year. This may be because of your management regime but you

will not be able to tell unless you also sampled paua in control areas subject to normal fishing regimes. Remember that the information you have obtained is relevant for your study area only and care must be taken about the interpretation of these results. Differences can occur over small distances of your coastline.

If you have collected data from your area of particular interest and adjacent "control" areas or if you have surveyed the area a number of years then you could analyse the data to see whether from a statistical point of view the populations differ in abundance and/or size. This is a technical task and needs specialist input. The Ministry of Fisheries may be able to help you do this analysis. Alternatively, if you have sufficient funding you could approach specialists at a University, Polytech or NIWA to complete the analysis.

16. Where to Next?

Treat your first survey as a pilot to plan your sampling in the following years. After your first survey has been completed get in contact with the Ministry of Fisheries. Ask them to advise you whether the sampling programme you have started has the statistical capacity to detect the sort of changes in abundance of paua and kina you expect over the time frame of any management regime you might put in place. For instance, a ban in fishing from an area may only be in place for two years. Will your sampling design allow you to detect say a 25% increase in abundance of paua? If not, you will have to increase the sampling effort.

After your monitoring programme has been running for a few years you can start to look for any changes and trends in the paua/kina populations you have been monitoring. You will also be able to try to identify the potential source of any problem detected. Once you have collected your data, it may be a good idea to consult with the Ministry of Fisheries, who will be able to give you further help in interpreting results, and will be able to advise on management issues. If you find a negative trend in your paua/kina populations, you can start to work on management measures to take care of the problem.

Once you are comfortable with the methods and procedures in this manual, and when more time is available to commit to the project, you may want to sample additional sites. Also, you may want to promote the monitoring programme to other communities around the coast and share information. This allows a picture to be built up of what is going on over a wider range of the coastline.

You may wish to obtain funding to support your monitoring efforts. Try your district council, the Ministry of Fisheries, the Ministry for Environment or the Lotteries Board.

If you have information on paua and kina abundance and sizes from a number of areas of differing management, say a marine reserve, a taiapure and adjacent coastlines open to all forms of fishing then these may be interest to the Shellfish Stock Assessment Working Group (see Chapter 4 for more detail).

Appendix A: Looking after your Paua Stocks

- Undersized paua are next year's or future year's harvests and should be treated with care. Do not remove undersized paua from the bottom, as paua may be damaged and may not survive.

- Always carry an in-water measuring device so that paua can be measured underwater. This minimises the risk of removing undersized paua. This could be as simple as marking the legal size limit on your trowel.

- Use paua friendly tools, such as a blunt trowel, which are not likely to cause damage to paua (no sharp instruments). Small cuts can lead to paua bleeding to death, or can cause abscesses, which will result in death.

- If undersized paua are removed by mistake always return them promptly, the right way up, onto the reef. Do not throw paua overboard, as they are unlikely to survive if they land upside down or on a sandy bottom.

- Change your fishing locations often and take a few paua from several different beds. This will ensure your favourite fishing spots are not depleted.

- Paua on deck should be kept in the shade, damp and covered, as paua dry out and will die if not protected from the heat and sunlight.

- Stick to the daily bag limits. In most areas ten paua are permitted to be taken per person per day, but take only what you need.

- Observe the size limits (125 mm and 80 mm for blackfoot and yellowfoot paua, respectively) which have been set in most areas. These limits allow paua to breed for a couple of years before becoming susceptible to fishing.

- Report any suspicious activity to the Ministry of Fisheries, including details on location, time, date, description of boat or vehicle type, colour, registration number, and details of the people and activities observed.

Appendix B: Contact Addresses for Ministry of Fishery Offices

Head Office	
P O Box 1020, Wellington	Phone: 04 470 2600
ASB Bank House, 101-103 The Terrace, Wellington	Fax: 04 470 2601
Auckland Office	
PO Box 3437, Auckland	Phone: 09 379 4700
23 Hargreaves Street, College Hill, Ponsonby, Auckland	Fax: 09 377 4245
Nelson Office	
Private Bag 14, Port Nelson, Nelson	Phone: 03 548 1069
118 Vickerman Street, Port Nelson, Nelson	Fax: 03 546 9327
Dunedin Office	
Private Bag 1926, Dunedin	Phone: 03 474 0333
1st Floor, 45 Filleul Street, Dunedin	Fax: 03 477 6275
Invercargill Office	
P O Box 1065, Invercargill	Phone: 03 214 2640
1st Floor, 137 Spey Street, Invercargill	Fax: 03 214 4325
Christchurch Office	
P O Box 8324, Christchurch	Phone: 03 358 0812
585 Wairakei Road, Christchurch	Fax: 03 358 0817
Kaitaia Office	
P O Box 143, Kaitaia	Phone: 09 408 2936
Braidwood House, 5 Allen Bell Drive, Kaitaia	Fax: 09 408 2951
Whangarei Office	
Private Bag 9013, Whangarei	Phone: 09 437 5543
17 Keyte Street, Kensington, Whangarei	Fax: 09 437 1851
Tauranga Office	
P O Box 13-125, Tauranga	Phone: 07 577 1640
Cnr of Elizabeth and Durham Streets, Tauranga	Fax: 07 577 9621

Appendix C: Random Number Table

Below is a table of random numbers that should be used to select sampling points in your study area. Randomly pick a starting position anywhere on the table by closing your eyes and letting your finger fall onto the page. The number your finger lands on is the first sampling position. Then use the next 40 consecutive numbers.

3	1	11	8	2	12	11	9
11	6	9	9	6	16	1	3
1	8	2	20	16	4	13	8
4	11	11	14	2	15	3	20
10	14	4	5	11	20	15	16
11	18	2	14	6	4	7	2
14	2	3	21	3	18	4	4
17	4	13	3	16	7	12	12
0	12	20	17	5	12	15	1
4	19	12	19	19	3	6	2
7	20	16	7	20	5	14	8
8	5	7	3	2	5	7	2
9	6	0	15	5	1	6	18
19	9	17	3	14	1	1	3
7	11	6	3	7	2	17	6
10	17	5	12	2	10	11	5
13	18	4	3	6	6	20	15
16	0	2	9	17	10	3	11
19	1	13	6	3	2	14	19
20	5	13	4	12	3	6	17

Appendix D: Useful sources of information

The Adopt a Beach Programme: A handbook to assist community groups in conducting their own surveys of local shellfish resources by Ministry of Fisheries and Sea Keepers.

A Community Guide to Monitoring a Cockle Population by M. Cassidy, H. Suter, and I. McGee (1997) Ministry of Fisheries, Dunedin.

Nature Watching at the Beach by J. Walsby (1990) Wilson and Horton.

A Guide to the New Zealand Seashore by D. Gunson (1993) Viking Pacific.

Studying temperate marine environments. A handbook for ecologists by M. Kingsford and C. Battershill, (eds.). (1998) Canterbury University Press, Christchurch.

Appendix E: Equipment Suppliers

50m metric tape: 50 m Yamayo measure tape - $55 + GST
Trig Instruments
7 McCormack Place
Ngauranga
Wellington Tel. 04 473 7935

Plastic Calipers (150 mm): $5-$7 Try Placemakers / Mitre 10

Paua Tags: Available for A$135 a roll of 1000 tags from
Hallprint Tags
27 Jacobsen Crescent, Holden Hill
5088 Australia
Ph: 0061 8 261 0312
Fax: 0061 8 266 3816
Email: halltag@dove.net.au

Selleys Supa glue for the shellfish tags (the gel glue doesn't work that well and nor do other brands!). Again Placemakers/Mitre 10.

PVC sheet (4mm) for dive slate about $5 (A4 size). Any industrial plastics supplier. You may be able to obtain a suitable sized offcut otherwise they sell them by the 2400mm x 1800 mm sheet! (expensive).

Field Kit Bag The field kit comes in a swagger bag ($48 each) made by
Bennet Enterprises Ltd
PO Box 38171
Wellington Mail Centre
Ph: 04 568 6532
Fax: 04 568 7532

Underwater writing paper: Only one type (Xeroperm Lazerprint 3R 96094) can be used in a photocopier to print up the sheets with headings and columns etc. If any other type is used it will melt inside the copier!!
$55 plus GST for 100 sheets
from Fuji Xerox NZ Ltd
49-55 Tory Street
Wellington

Appendix F: Glossary of Terms

Abundance: an index of how many paua or kina are present. It may not be accurate, but needs to be sufficiently consistent that it can be compared among places, or among times. All sampling methods discussed here will provide an estimate of abundance.

Accurate, accuracy: how repeatable an estimate is. An accurate estimate is what we want to get from our sample. Inaccuracies may arise because of errors inherent in how we measure or count things or the patchy distribution of the study organism.

Bias: getting an inaccurate picture of what the world is like because the sampling method is slanted toward one species or size class

Census: a full count of all the individuals in an area. Very difficult to get.

Density: an abundance per area of seabed. Only diver counts provide densities; other methods provide estimates of relative abundance.

Distribution: where things occur. For example, a description of the distribution of paua might be "shallow tumbled boulders".

Habitat: the type of seabed present, classified by the substratum type (e.g. rocky reef), and vegetation (seaweed forest).

Maximum: the biggest number seen.

Patchy: things that are found in clumps have patchy distributions. Both paua and kina tend to have patchy distributions, and as a result estimates of their abundance are often not precise.

Precise: all of the replicates having similar values.

Random: not determined by choice. There are tables of random digits available, and these can be used to decide which order to sample the sites in. This is a way of avoiding biases in the data.

Replicates: repeated sampling units within a single area. For example 5 replicate transects per site, 3 replicate pot-sets per day. Often indicated by "*n*=" in written reports.

Rugose: bumpy or rugged, e.g. where there are large boulders on bedrock, or pinnacles.

Sample: when you can't collect everything that you're interested in, you need to sample, so you can estimate the total number. For example, if you count paua in replicate transects at a site, you can estimate the total number in the area, although you haven't carried out a full census.

Sedentary: things that don't move very much. Both paua and kina are sedentary, because they spend most of their time sitting on the bottom of the ocean.

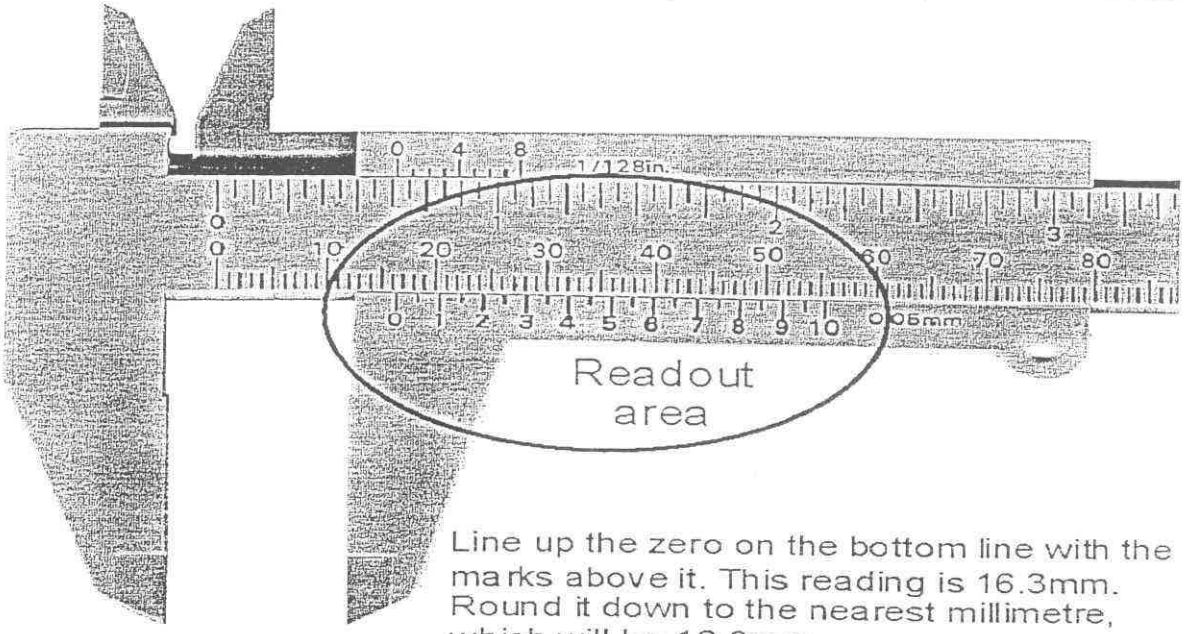
Site: a defined area in which replicate samples are taken. It is usual to sample a number of sites within an area of interest, and compare them with nearby areas that have different management regimes.

Transect: an area of seabed, usually longer than it is wide, in which paua and kina are counted.

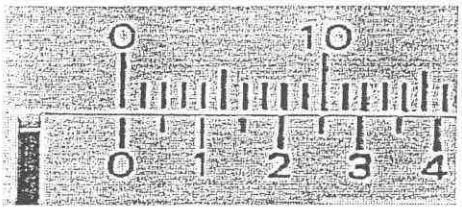
Visibility: how far you can see underwater. This can be estimated by using the distance at which an object (e.g. a diver, or dive slate) vanishes from view. Visibility < 4 m is unsuitable for paua and kina counts, whereas at offshore islands with little runoff from land, visibility in excess of 20 m may be encountered.

Appendix G

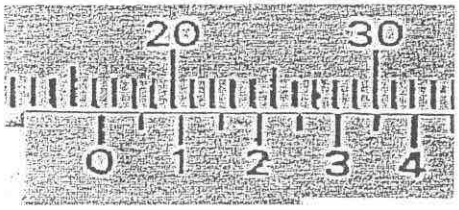
Calipers and readouts



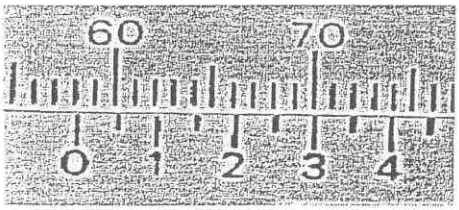
Line up the zero on the bottom line with the marks above it. This reading is 16.3mm. Round it down to the nearest millimetre, which will be 16.0mm.



Example1 - the value is 0



Example 2 - the value is 16.3
Round it down to 16.0mm.



Example 3 - the value is 58.05.
Round it down to 58mm.