NIWA
Taihoro Nukurangi

Restoring shellfish beds to harbours and estuaries

A guide for community groups

Version 1
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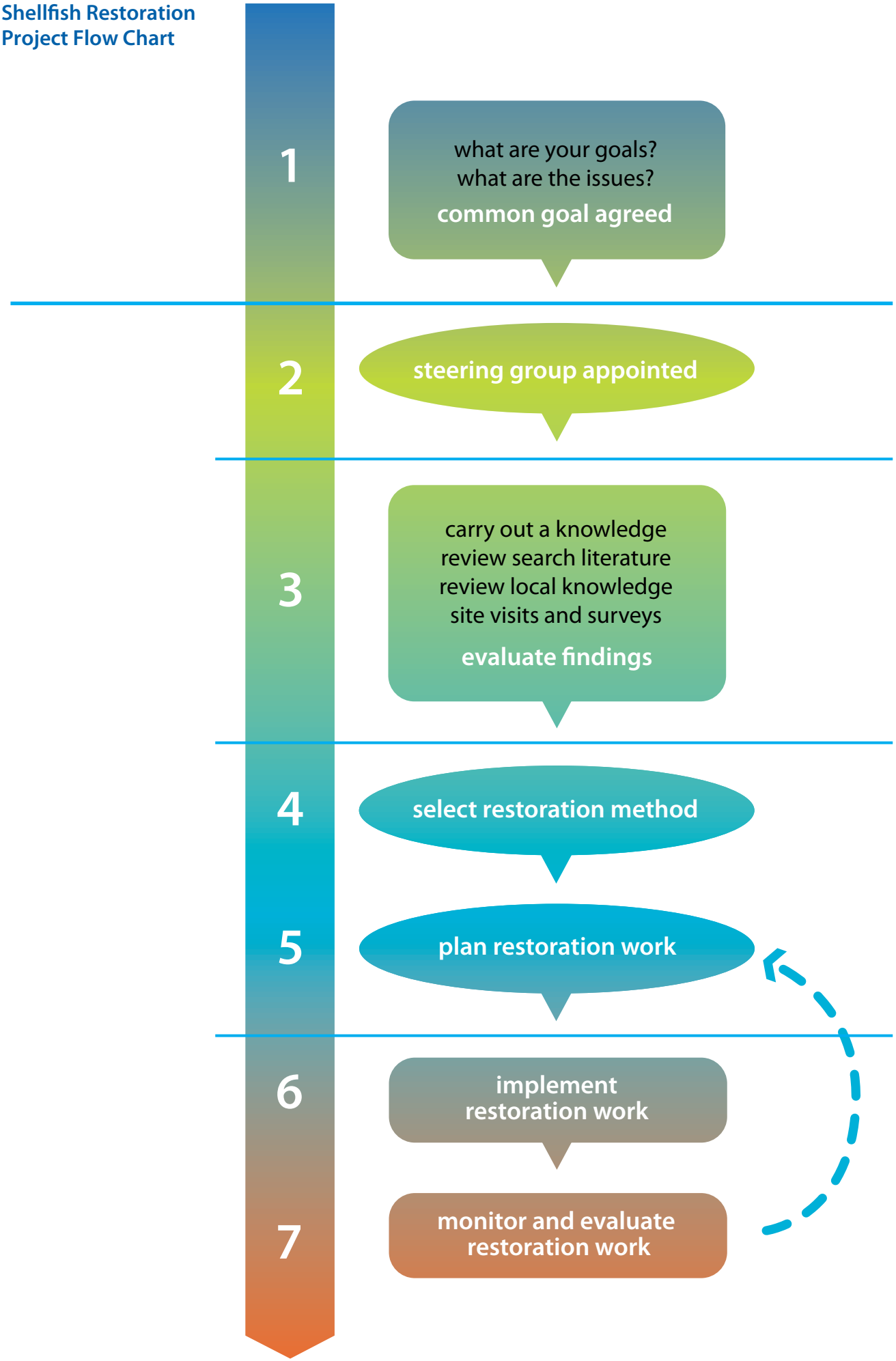
Shellfish Restoration Project Flow Chart



About the guide

Welcome to the **Restoring shellfish beds to harbours and estuaries** guide. This guide is to assist community groups who are keen to undertake a shellfish restoration project. It is designed for groups who have some harbour and estuarine shellfish monitoring experience, and who have also identified restoration as a priority.

The guide is based on knowledge and information gained from years of working in New Zealand's harbours and estuaries and, more recently, from a project in collaboration with Northland Regional Council, the Whangārei Harbour Kaitiaki Roopu (as guardians of the harbour) and the National Institute of Water and Atmospheric Research Ltd (NIWA). The project ran over five years and aimed to establish the best method for reseeding cockles in Whangārei Harbour[1].

Seven key steps (refer Shellfish Restoration Project Flow chart) are used as a framework to structure the guide. The guide can also link to more detailed information contained in other community monitoring guidelines, such as the *Ngā Waihotanga Iho* – (translation: what is left behind, lift up) *Estuary Monitoring Toolkit for Iwi.*(NWI)[2]

The drivers for restoration projects will differ between groups depending on the vision, values, goals, and the issues faced. Steps and instructions given within, can be adapted to suit your own knowledge, vision, and circumstances. Please remember that a one size fits all' framework may not be suitable for all shellfish restoration projects.

Contents

[1] Towards the long term enhancement of shellfish beds in the Whangārei Harbour. Part 5B Project Synthesis.

[2] NWI is in its final stages of development by NIWA for **late 2010** release. It has been developed to provide tāngata whenua with tools to measure environmental changes in their estuaries based on sound science principles underpinned by tāngata whenua values. The toolkit is comprised of nine modules: Estuary Origins, Habitat Mapping, Sediments, Plants, Tidal Flat Ecology, Fish, Water Quality, Bacteria, and Coastal Management.

What is restoration?

Restoration is the re-establishment, by human actions, of a species, community or habitat which has been lost or depleted due to natural processes or human impacts.

Restoration is typically conducted where the likelihood of natural recovery is low, or expected to be slow, after the cause(s) of loss or depletion have been removed.

New Zealand's coastal habitats are under increasing pressure from land-use changes, development and extreme climatic conditions. This often leads to the modification and, in some cases, deterioration of habitats. As a result, valued vegetation, fish, and shellfish stocks can become severely depleted or wiped out.

Communities are very concerned about the decline of shellfish populations. Habitat change or overfishing often mean that shellfish are not as abundant as they once were. Therefore, the focus lies in developing positive and practical initiatives to restore and protect shellfish resources. These initiatives can be achieved through a combination of active management and restoration efforts.

However, any efforts to restore an area must take into account broad harbour and estuarine management, rather than simply focusing on shellfish. The environmental and human threats that have led to deterioration in shellfish resources must be assessed, and natural ecological processes understood.

Restoration is unlikely to succeed unless sources of degradation and threats are managed, and it is only through knowledge that practical restoration decisions can be made.

It is highly recommended that community groups initiate a long-term monitoring programme to build understanding and improve the general 'health' of their coastal environments, with restoration efforts being one potential component.

Box 1: Restoration Case Study – Whangārei Harbour

In 2003, NIWA was commissioned by Northland Regional Council, in conjunction with the Whangārei Kaitiaki Roopu, to coordinate a five-year restoration project aimed at determining the best method for reseeding degraded cockle populations in the harbour. The focus was on enhancing numbers of harvestable shellfish (cockles larger than 35 mm and pipi larger than 50 mm). Initially this involved:

- meeting with the Kaitiaki Roopu of Whangārei Harbour
- reviewing available information
- further discussions about the harbour's historical shellfish resources
- surveys of each site
- development of recommendations for viable restoration efforts.

Community engagement was vital to the process. The community needed to be fully aware of the issues and the long-term commitment necessary for the restoration project to succeed. In addition, clearly defined and realistic goals were agreed, once people understood that broader habitat changes mean that, in some places, cockles are unlikely to grow as large or be as abundant as they were in the past.
A core community working group was established to lead the planning and implementation process in subsequent years.

Project goals

- 'Bring the harbour alive'.
- Combine traditional and scientific knowledge.
- Create a model for other groups/harbours to pass on the knowledge gained.
- Educate people about shellfish issues.
- Eventually pass full ownership of the re-seeding project to the working group.

It was agreed that one species (cockle) would first be trialled in one site. Different reseeding methods were also trialled in subsequent years to determine those with the best chance of success in Whangārei Harbour.
Adult cockles were collected from elsewhere within the harbour; measured, marked and then seeded in a variety of plots in the Takahiwai area. Results demonstrated that for the Takahiwai sandflats:

- the best reseeding density is 180 individuals in a 60 cm x 60 cm plot (500 per square metre)
- plots should be arranged in a patchy manner on the sand-flat
- protecting the plots from predation by installing cages had little effect on survival
- cockle death was strongly associated with weather conditions (high winds, low rainfall, and larger temperature range).

Step one: Agree common goals and issues

Knowing why you want to undertake restoration will determine your approach. This will depend on your overall vision, values, issues, and restoration goals. It is important that goals are identified, discussed and agreed at the outset, and viewed as part of the wider management considerations of your area in question.

Healthy harbours and estuaries are often robust and resilient, while those showing signs of environmental degradation are usually more prone to negative impacts. While single issues can have significant harmful effects, often the greatest deterioration in harbours and estuaries is caused by a combination of cumulative issues. Unfortunately, most of these issues are directly attributable to activities associated with modern society, such as:

- sedimentation – even small increases can cause death of shellfish; caused by changing land use such as subdivision or forestry clearance
- pollution – direct discharges of heavy metals and chemicals into waterways or run-off from urban and industrial areas
- nutrients – agricultural sources such as fertiliser, animal waste; human sewage treatment or septic tanks
- fishery harvest pressures – commercial, recreational, customary, illegal
- invasive species – more predators, competition for food/space, introduction of new parasites and diseases
- dredging – often necessary for maintenance of port access, significant impacts from disposal of sediments (dredge spoil).

Such issues often demand management intervention. While large scale factors such as climate change or other broad environmental changes may be beyond your control, community-level actions are possible to help reduce or offset some problems.

Remember too, that unpredictable factors, such as weather, may have significant impacts (both positive and negative) on the outcomes of any restoration project.

Communities who have already implemented long-term harbour and estuary monitoring have the advantage of understanding what threats exist in their area, and are more able to identify suitable sites for restoration.

Involving your local community

People driving the initiative for shellfish restoration can unite community support with a series of meetings to discuss and agree the groups' vision, values, goals, and issues. Involve interested community members, including tāngata whenua/hapū/iwi, key regional council staff, representatives from organisations, for example, Ministry of Fisheries (MFish), Department of Conservation (DoC), NIWA, MAF Biosecurity, universities, and members of the local fishing industry. It is through these groups working together, building knowledge, educating and raising awareness of shellfish issues and management options, that the health of the marine environment can be improved and restoration goals realised.

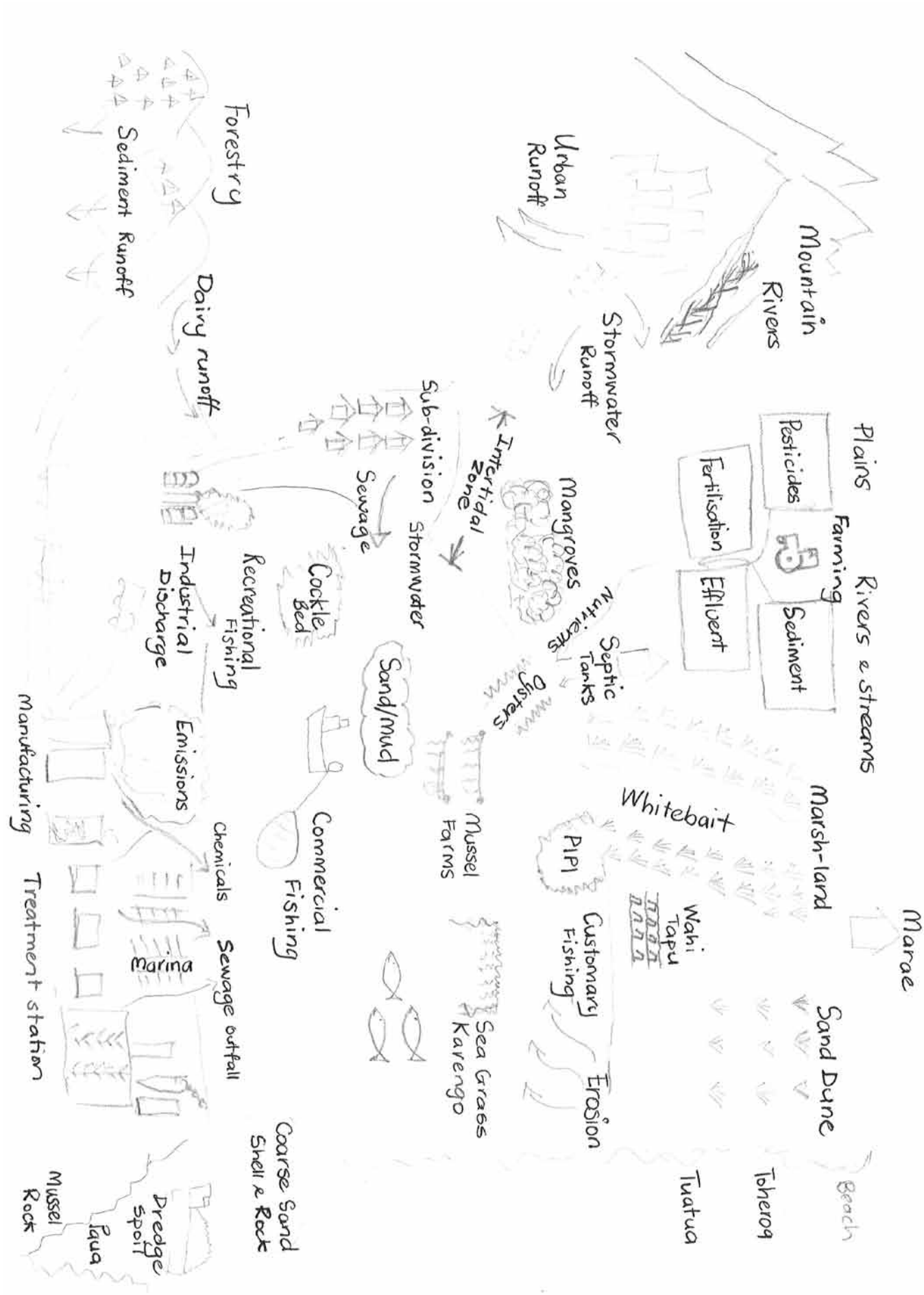
Participants need to be realistic and practical in their expectations. Remember that, because of broad environmental changes, increased population pressure, and coastal development, it is unlikely that shellfish species will ever grow as large or be as abundant as in the past.

Question examples to address with local people

- What is the community's long-term vision for the harbour/estuary?
- What are the goals of our shellfish restoration project?
- What shellfish species does the community want to restore?
- What are the main issues or concerns affecting the selected shellfish?
- What sites do you want to restore?
- Who else should be involved in the process?

A useful way of getting people involved in community meetings, and increasing understanding of the challenges faced in restoration, is to 'brainstorm' and sketch all the things affecting the harbour or estuary catchment, (see Box 2). This sketch can then be tidied up and re-used for discussions with individuals or groups throughout the restoration process.

Once broad agreement has been reached on these key elements, you have completed 'Step one' and have established the 'why' and 'what' of the project. The next step is to select 'leaders' to guide efforts.



Box 2[VC1]: Example sketch of your harbour/estuary

Step two: Appoint steering group

Restoration projects generally require a lot of work, and long-term and consistent commitment over several years before any benefits may be realised. It is recommended that a community **steering** or **working group** is established early on with agreed roles and responsibilities such as group leader and community liaison. The main function of this group will be to drive and guide the restoration project through to completion.

A successful project will be labour intensive, and will require sustained and inspirational leadership and drive. For example, if transplanted shellfish are initially caged to help them become established, people will have to be motivated to carry out regular checks and cleaning of the cages, over months-years, to prevent them silting up, and the shellfish dying.

The next key step is to carry out a 'knowledge review' to determine the current state of your shellfish and site(s) of interest.

Step three: Carry out a knowledge review

The next step is to organise and coordinate a comprehensive knowledge review. This will cover your selected shellfish species, potential restoration sites, and any issues affecting them. Local, traditional, and scientific knowledge sources need to be included to discover the best available information.

Successful shellfish restoration can only occur if the factors responsible for the decline are no longer present or have been reduced to a manageable level. If possible the community should identify a number of the potential restoration sites, which can then be evaluated as part of the knowledge review, with the choice of the final site(s) being based on thorough investigation.

The knowledge review will gather information to help with the selection of the most suitable restoration method(s) and provide a clear foundation for your restoration plan and its implementation.

Key information to collect

- What is the current condition and use of the shellfish resource? What is the present, and what were the past, distributions and abundances?

For example, what shellfish beds are there now and where are they?
What were they like in the area when you were young?
How much is there now compared to back then?

- Are there particular harvesting practices and significant sites?

For example, are there waahi tapu sites respected and protected by tāngata whenua?

Where do recreational, customary, commercial, and illegal fishers harvest from? Has this changed over time?

- What are some of the possible factors that have lead to the loss or depletion of the shellfish?

These can be natural disturbances like erosion or algal[3] blooms, or human disturbances like sedimentation, pollution or over-harvesting. Often, it is a combination of several land-use factors throughout the catchment[4] inputting into the harbour or estuary that leads to impacts.

- Is this disturbance continuing or has it been removed or rectified?

[3] Algae are plants living in water. The larger varieties which are fixed to one spot are commonly known as seaweed (e.g. kelp); others that are microscopic, floating freely in the water column, are known as plankton. Usually algal blooms refer to seasonal periods of massive growth increase in plankton, producing visible events such as red tides which can have significant impacts, though large algae such as sea lettuce can also sometimes cause nuisance blooms.

[4] 'Catchment' is a term used to describe the entire land area over which rainfall can collect and flow down into streams and rivers, eventually ending up in the sea. This is an important factor to consider, as this process is a major source of sediments, nutrients, and pollution that can negatively affect estuaries and harbours.

- Are there existing or potential threats from invasive nuisance species?

Fast breeding or voracious predators such as starfish, crabs and snails, whether present at the start of a project or introduced later on, can have devastating effects on the ecology of estuarine habitats. Similarly other species that colonise in large numbers can compete for space and food. You should assess if they are present, determine what can be done to reduce their impacts, and ensure that your project plan incorporates ongoing monitoring for invasive species. It is recommended that you engage with MAF Biosecurity New Zealand for specific guidance.

- How are the shellfish beds currently managed?

For example, who manages the beds? What are the fisheries management regulations and options?

- Which types of shellfish are still naturally found in the areas you want to restore?
- Are the restoration sites suitable for your target shellfish species?

Use and add to your original sketch map of your harbour/estuary, noting locations of significant features, key habitats, resources and activities (see Box 2). This visual summary of important features will help to identify the main factors and threats to consider when developing your action plans.

Wealth of local knowledge

New Zealand's coastal areas have long-time tāngata whenua and local residents who will have valuable knowledge of the area, its history and shellfish. The steering group may like to hold meetings/hui to engage with residents, tāngata whenua/hapū/iwi, community conservation and resource organisations, that have local shellfish and area knowledge. The steering group leader or an independent person can facilitate the discussions. He/she can also facilitate reporting back, time and record keeping, and importantly maintain enthusiasm!

For individual discussions, talk to as many people as possible but always keep in mind that one person's recollection may not be the same as another's. It is wise to have a couple of key questions to help guide these discussions. For example, to get an idea of how local harvesting and shellfish abundance may have changed over time, you could ask 'how long did it/does it take you to fill a bucket?' and 'how deep did you have to go out to get it?' The sketch of your harbour/estuary and/or aerial maps are great to use to generate discussion and record information.

Undertaking a literature review

A comprehensive review of all available information about the selected shellfish and your harbour/estuary is also needed. This literature review will identify potential restoration sites and any issues affecting them. The review need to be done before any restoration effort begins. Sources of information could include:

- local/regional council
- universities - e.g., libraries, student reports
- Ministry of Fisheries (MFish)
- Department of Conservation (DoC)
- Ministry for the Environment
- MAF Biosecurity
- NIWA and other local science organisations for any relevant studies/reports/maps/papers/websites.

The information sources will help to identify important shellfish life cycles[5], habitat characteristics, current fisheries management regulations and options, or any other useful information, such as previously known historical maps and impacts affecting that site (e.g., sedimentation, pollution etc). Ideally, you will find a local community member or university student with experience in carrying out literature reviews, knows where to look for information, and can summarise it in a way that is easy for others to understand.

Often you will find that there is either no existing information in the literature specific to your sites, or that what is available is old and out-of-date. However, it is valuable, as information may be revealed that will be useful to your project.

Understanding target shellfish species and their restoration site(s)

The knowledge review will provide information on a number of key factors that are likely to affect the growth and survival of your selected shellfish. These include things like the physical environment (e.g., waves and sediments), water quality, pollution, over-fishing, and the biological environment (e.g., predators, food availability, invasive pest species).

The site you select needs to match the habitat requirements of your target shellfish species as closely as possible, otherwise their growth and survival may be reduced. For example, it is pointless trying to transplant shellfish that prefer a muddy habitat to a sandy area, or to transplant shellfish that prefer a sheltered environment in one that is exposed to lots of waves and currents.

There are a number of different characteristics of a habitat that, in combination, contribute to its suitability for shellfish. Habitat characteristics to look for are listed in Box 3.

Site visits and surveys

Site visits and surveys are the best way to assess the current habitat characteristics, and determine the status of both the resident shellfish population and other animals/plants that are living at the site(s) now. Surveys will provide information on sizes and distribution of the shellfish at each location, and will act as a baseline[6] against which you can later evaluate your efforts. Ideally, shellfish surveys would be part of wider ongoing monitoring which will help you to identify other environmental changes in your region.

If possible, initial surveys should be undertaken more than once during the first year prior to restoration activities, as shellfish numbers will vary seasonally. Note that when you re-evaluate shellfish numbers after your restoration project, you need to repeat surveys at the same place, and at the same time of the year as your original surveys were conducted.

[5] Shellfish species in particular have distinct phases of their life cycle, such as drifting on currents in their planktonic stages, settlement onto hard/soft surfaces or breeding, each of which may have different requirements and vulnerabilities.

[6] A baseline provides a snap shot of your estuary at a moment in time. It is important because it sets the benchmark by which to determine the extent and rate of future environmental changes. The baseline survey would typically include all aspects of the estuary's condition: its habitats, waters, sediments, plants, animals and kaimoana.

Box 3: Habitat characteristics

Habitat characteristics	*Details*
Sediment type	Sandy or muddy? Shelly? Coarse sand or fine sand?
Site exposure and stability	Is the site sheltered from wind and/or waves? More exposed sites are likely to experience more wave disturbance of the seafloor, and are therefore less stable.
Food availability	Microalgae associated with sediments? Plankton in the water column? NB. Many shellfish are filter feeders [e.g., cockles, pipi, scallops, oysters, mussels, but some are deposit feeders on the sediment surface [e.g. wedge shells, whelks], or grazers.
Tidal regime	Nature of the intertidal area – large expansive sandflat or narrow steep rocky habitat? How long is the site exposed for at low tide? How strong are the tidal currents?
Salinity	How salty is the water? Where is the site located in relation to the open coast? Is it near a stream/river mouth?
Potential disturbances	What is the surrounding land like? Is it steep? Is there a chance of sediment erosion during high rainfall? Is it subject to disturbance from human activities? Are there any inputs upstream or near-by that could affect water quality (e.g., factory discharges, nutrient run off)? Are dredge spoils dumped in/near this area? Is it a heavily used area for fishing, boat anchoring, harvesting (recreational and commercial), etc?

A brief description of how to conduct a shellfish survey is provided in Box 4. However, this is only a summary, and we recommend you refer to the Shellfish module of NWI. This module tells you how to measure and monitor boundaries of your shellfish beds, as well as the numbers and sizes of the shellfish. The Hauraki Gulf Forum website also contains useful information on shellfish surveys (http://www.arc.govt.nz/environment/coastal-and-marine/hauraki-gulf-forum/community-shellfish-monitoring.cfm).

Surveys are designed to sample representative spots on the harbour or estuary, and this data is then used to estimate shellfish numbers in the entire area. They can be used to provide information on more than just the shellfish you are interested in - for example, the presence or numbers of other shellfish, crabs, whelks, and invasive species. This extra information can be valuable in helping to explain any changes you may see in your area over time.

Evaluate review, confirm restoration species and site(s)

Armed with all the knowledge review information, the steering group must now assess the current situation and decide on the most appropriate shellfish and site(s) for restoration efforts. At this point you may also have to re-evaluate your restoration goals. Such decisions are not always easy as sometimes the shellfish species a community wants to revitalise may not be suitable for the area they want to restore.

Do you restore:

(i) the beds that you remember as being used to gather a specific shellfish?

(ii) a specific area that you want to use? or

(iii) another area that is more likely to be suitable for the shellfish that you are interested in?

Depending on which species you wish to restore there will be many specific considerations that will affect the success of the project. Also, as shellfish species grow they have different requirements for optimum growth and survival. For many species, knowledge of these particular requirements is limited. International shellfish restoration efforts have produced mixed success rates, with the only consistent outcome being that there is no 'one size fits all' recipe for success. The good news though is that it can be done, as demonstrated here in New Zealand in the Whangārei Harbour.

Box 4: Conducting a shellfish survey: the basics

Be prepared! Know the shellfish you are targeting as well as other species of key interest (predators, invasive species). It is helpful to have laminated information resources on hand to help with identification.

- Lay out a transect line (e.g., 50 m long tape measure or rope, anything of known length that can be repeated in exactly the same position in subsequent surveys) orientate up and down the beach and across the sandflats (i.e., from high to low tide marks, at right angles to the shore).
- Mark spots every 10 m along the line.
- Place square 'quadrat' on the sediment of known dimensions (e.g., 50 cm x 50 cm), dig out contents (to around 10 cm maximum depth, depending on the shellfish you are looking for) into a tray, bucket or sieve to remove any live animals. Using a quadrat will help to easily define the area to dig up (see Appendix 1 for a DIY quadrat).
- Carefully sort through the sediment you have dug out to find live animals. Count and measure number of individuals of any shellfish species found (or at least of the species of interest). Measure them at the widest part of the shell (there are a variety of methods for ease of use in the field: callipers, ruler, pre-marked sticks, 'V' board, sorting them through a stack of different sized sieves, or by having size classes pre-marked on a tray). Count, or at least note the presence of, other animals (e.g., crabs, whelks).
- Repeat process at each position along the transect line.
- Now move the transect line further along the shore, parallel to the first one, and repeat the process.

NB. How long your transect is, how many positions along the transect you sample, and how many transects you do across the beach, will depend on the size of the beach (length and width when the tide is out).

Check it out first at low tide to figure out how big an area to survey. If the beach is huge, you can sample selected areas only. Be sure you are able to relocate the area you sampled (to within a few meters) for next time. See the NWI monitoring section (for details on how to arrange your transects on the shore, how many transects and quadrats you'll need.

Step four: Select restoration method

Here you need to make decisions on things like:

- What method is best to use?
- What size and numbers of shellfish should be transplanted?

Deciding on what method to use

There are two main options for sourcing the stocks for reseeding: (i) hatchery-reared individuals, or (ii) transplanting existing individuals from elsewhere (see Box 5). There are no hatcheries in New Zealand producing common intertidal shellfish species like cockles and pipi. Transplants involve moving shellfish from naturally abundant beds (preferably located within the same harbour or estuary) to an area of low abundance or productivity. In the Whangārei Harbour project the option of transplanting adult individuals from elsewhere in the harbour was favoured.

The technique that you choose will depend on the shellfish species, the life history stage that you are working with, and the size of the area that you are trying to restore. The species you select, and its stage of development (size and maturity), will determine the need for predator protection, and whether you will need to restrict shellfish movement away from your transplant area. Information on mobility of different life history stages and predators of shellfish should have been identified from your knowledge review.

Shellfish mobility

Smaller shellfish and/or individuals are likely to move about more, and so may require some form of cage to prevent this from happening until they are older, larger, and therefore less mobile. This is especially true for cockles. However, other common intertidal species, like pipi, are also very mobile as adults (they produce mucous threads that enable them to become more buoyant and float around in the water column), so caging may be necessary at all stages of their life cycle to ensure they stay within your target area and for ease of monitoring the results. In some areas, installing a cage may require a permit from the local council.

While you may have added pipi to a relatively small area (e.g., 10 m x 10 m) over time they are likely to move out of this area. Therefore any monitoring you implement should cover an extended area around the reseeded plot (see Step six: Monitor restoration work). You might also want to consider monitoring populations in several areas, for example, the transplant area, plus local areas where currents are likely to have transported these mobile shellfish to. Alternatively, you can just accept that these shellfish may not remain where you put them, but that they will be enhancing the overall population in your harbour/estuary.

Predator protection

Common predators of intertidal[7] estuarine shellfish include starfish, crabs, whelks, rays and shorebirds. There are different types of predators which prey on different life stages of shellfish.

[7] The area of seafloor between high and low water marks, which is exposed as the tide goes out.

Generally, rays feed on smaller shellfish; different species of crab, whelks and shorebirds prey on particular shellfish life stages and size classes. For example, red knot and godwit feed on small shellfish, while oystercatchers prey on adults.

The types of predators that are most abundant will also vary with water level on the beach; e.g., paddle crabs are more likely to be a problem low down on the shore, as they move up into the shallows during high tide.

Using a cage is one of many ways of protecting your shellfish. Getting the right mesh size for your cage is very important and should be sufficient to stop the shellfish from escaping, while preventing the predators getting in. Cages need to be anchored down to prevent them being washed away, and must be regularly checked to ensure that they remain buried deep enough in the sediment, whilst still protruding far enough above the sediment surface to allow the shellfish to feed. They should also be checked to ensure algae are not catching on the mesh and clogging the holes, they do not become fouled (e.g., with barnacles) or silted up, thus preventing water flow through them. Cages would usually only be used in the initial stages of restoration; as once your shellfish become established and the population builds up, there should be sufficient numbers to allow for natural predation.

Transplant arrangement

How you arrange your shellfish on the beach will depend on your target shellfish, i.e., should you arrange them in patches, or distribute them evenly across the area? Generally, organisms are patchily distributed in nature (note that very large patches are easier for predators to find), and we would recommend using this approach.

Harvest management

You may like to investigate options of managing harvesting in the area, to minimise disturbance while your reseeding becomes established. Your prior investigations of the current issues and situation of shellfish in your estuary or harbour will hopefully have identified the different management options that may be available. For example, spatial fisheries management tools exist under the Fisheries Act 1996 (i.e., Taiāpure – local fisheries, 186 A & B closures) and the Fisheries (Kaimoana Customary Fishing) Regulations 1998 (i.e., Mātaitai Reserves). Please talk to your regional council, MFish and DoC staff to help identify the most suitable fisheries management options.

Box 5: Transplant options – what size individuals do we transplant?

There are two main options for sourcing shellfish stocks for reseeding: hatchery-reared individuals, or transplanting existing individuals from elsewhere. If you are planning a large-scale reseeding operation, you need to ensure there is a plentiful supply of your chosen species.

We chose to transplant adult-sized cockles in the Whangārei Harbour cockle reseeding project in preference to other sizes of cockle, because:

(i) a plentiful supply of spat (juvenile stages) was not readily available

(ii) smaller size classes are harder to protect from predation and tend to have lower survival rates

(iii) transplanting adults (25–32 mm) provides a supply of already-reproductively active individuals which can replenish the local population in a shorter time frame

(iv) adult stages are less mobile than juvenile ones, and so are more likely to remain in the transplant area. Initially 40–50 individuals were seeded in 30 cm x 30 cm plots, but later trials indicated that 180 individuals in 60 cm x 60 cm plots produced the best results, despite being effectively the same density.

There are other things to consider before deciding to transplant from an existing population. The supply site needs to be carefully assessed to ensure sufficient numbers and sizes are available, and that their removal will not result in depletion of stocks at the site, cause considerable site disturbance, or have adverse effects on the existing seafloor community. Transplanting shellfish from outside your harbour or estuary should be avoided, as this could disrupt the genetic composition of local stocks and may also introduce parasites or diseases that are not already found in your harbour.

Shellfish can move!

Many shellfish species are capable of moving. Their mobility varies at different stages of their development. For example, cockles, pipi and wedge shells all have highly mobile juvenile stages. So carefully choose which life stage you reseed as they might not stay where you have put them!

Step five: Plan and implement restoration work

Once you have decided on your

> site

> shellfish species

> method

> and have undertaken your baseline survey,

the next step is to develop your implementation plan, and organise teams and team leaders for work on the beach/sand-flat.

To make a real difference and see visible benefits in terms of shellfish harvests, you may need a large-scale reseeding project, with a long time commitment for restoration and monitoring. To some extent the scale of your project will have to depend on the number of people you have available to do the work. Think carefully about the time needed to do what you have planned. Make a list of tasks, estimate how long it will take to do each one with the number of people you have available to help. The beach will be uncovered by the tide for about two to four hours, depending on tides in your area. Check this out using tide tables and visits to the beach, and revise your plan accordingly.

Remember that unforeseen events or circumstances beyond the group's control may compromise results, possibly even requiring several attempts before success can be measured. It is easier to manage expectations at the beginning; otherwise participants could get disillusioned at apparent lack of progress.

A few points to note:

- Make sure you have all the necessary permits. These are required for collecting large numbers of shellfish, and for disturbing large areas (e.g., when conducting your survey) and/or inserting structures on the beach/sand-flat (e.g. predator cage protection). Contact MFish and your regional council in the first instance, tell them what you plan to do, and they will advise you on the permits needed. Do this several months before you plan to do the work as it may take some time to process.
- Check the tide tables, and ensure the field team is aware of how much time is available for working at each site. Safety precautions are needed to deal with the possibility of people getting stuck in the mud, caught by the tide, or getting wet and cold (See Box 6 – Safety planning).
- Record everything you do throughout this process. It is easy to forget those little things you think you will remember! Taking photographs of your work will also provide a very useful record. A list of useful field equipment is given in Appendix 1.

Protection of the Restoration Area

By now you will have realised the significant investment of resources necessary to undertake a restoration project, and the frustration that will arise if all that effort was in vain. So give serious consideration to protecting the project outcomes at the planning stage, well before the reseeding operation begins. Discussions with the community should include options for implementing harvesting restrictions or a prohibition through customary tools i.e., S186A&B Temporary Closures/Method Restrictions[8].

Communications Planning

At this stage of your project it is recommended to develop a communications plan to ensure that all members of the local community are aware of your intentions and activities. This process could include:

- organising a programme of community meetings
- planning a media release
- preparing signs for areas being reseeded
- creating information resources for a community display (eg, local shop windows) and/or information handouts
- organising a letterbox drop

[8] Refer to Ministry of Fisheries – Customary Management for further information.

Box 6: Safety planning

Working in the outdoor environment can be dangerous, and there is a variety of hazards to be considered and managed. The key element of risk management is identifying the hazards beforehand, and undertaking sufficient planning and preparation to reduce the associated risks.

There are four core areas of risk management that should be addressed:

1. people – age, fitness, experience, medical condition
2. equipment – clothing, food, communications
3. environment – weather, tides, footing
4. activity – is there anything inherently dangerous with the tasks involved?

On the day it is essential to brief all the people involved properly, giving precise information on logistics, locations, risks and emergency procedures before work begins.

For estuarine surveys, as a minimum cover the following aspects:

- check forecasts in advance, ensure everyone is briefed
- visually check prior to starting fieldwork, and throughout activities.

Identify all potential hazards well in advance, for example:

- heat/cold exposure
- sunburn
- injuries through cuts and falls
- getting stuck in soft mud
- wildlife – stingrays, jellyfish etc
- fast rising tide cutting off access
- presence of deep gulleys in channels
- boat operations, propellors, emergency propulsion/communication, flares, lifejackets.

Ensure each person is safe:

- set up a buddy system
- plan on-site communications – Marine VHF radio, cellphone coverage, walkie-talkies, whistles.

Proper preparation is critical, both for the organisers and the participants. Project leaders need to ensure that there is sufficient equipment to respond to any potential incidents (e.g. ropes, sunscreen, fresh water, first aid, blankets/towels, communications). Each individual should also bring appropriate clothing for the job to be done and the time of year (covered shoes, diving boots, wetsuits, something to change into), sunhat/glasses, and sufficient food and water for the day.

Step six: Monitor restoration work

While this step is primarily concerned with monitoring the results of specific restoration activities, remember that a broader monitoring programme looking at wider concerns in the harbour/estuary will help identify factors or changes that were possibly unrelated to the restoration project.

Monitoring your work to assess survival of your shellfish will be very important to help measure progress and determine the success of your restoration efforts, and will provide valuable information on what works best in your area. It is especially important to monitor progress early after reseeding, to check both the initial survival rates and to ensure that any equipment installed on the sandflats have remained in place.

We suggest routinely monitoring the shellfish for survival, as well as monitoring the sediments surrounding them to ensure they have not become more/less silty, and noting the presence of any predators in the area. For example, if sediments get siltier the area may become less suitable for your shellfish and other animals. It would also be valuable to incorporate monitoring for invasive species. Information on how to monitor these factors is provided in the Sediment and Shellfish modules of NWI.

If predators are recorded in increasing numbers, you might need to consider protecting your shellfish if possible and practical (e.g., by caging).

Monitoring should be done at least twice per year, but we also recommend that more regular visits are made to the area to check for any obvious changes (e.g., deaths of your shellfish, increase in abundance of algae at the sediment surface, evidence of disturbance by humans and other predators).

How you have added your shellfish to the beach/sandflat, and which species and stage of development, will dictate the way you should monitor them (eg uncaged adult cockle may not move far, but uncaged adult pipi could have moved beyond your survey area). An example of a monitoring sheet used by the Whangārei Harbour group, on which all data was recorded while on the sandflat, is provided in Appendix 2.

Ultimately you are trying to determine how the addition of your shellfish has affected the shellfish population in that area. Have you enhanced the population? Have your transplanted shellfish remained where you put them?

With your baseline survey, you can compare the 'then' and 'now' data and evaluate your work.

If you were unable to collect baseline information, then you need to monitor an adjacent area where you did not add shellfish as a comparison. This area should be situated close by and have the same habitat characteristics as the site you are working in (e.g., it must be at the same tidal level on the beach/sandflat, have the same sediment characteristics, and must be subject to the same degree and types of disturbance as your site).

Step seven: Evaluate restoration work

How successful is your work? Have you achieved your goals? Monitoring your project provides valuable feedback on its success. Have a look at the results and compare them to your 'before' or baseline information. This will tell you things like whether you have enhanced numbers of shellfish at your site(s), and whether the site has changed. It will also help you refine your restoration procedure by identifying the lessons learned.

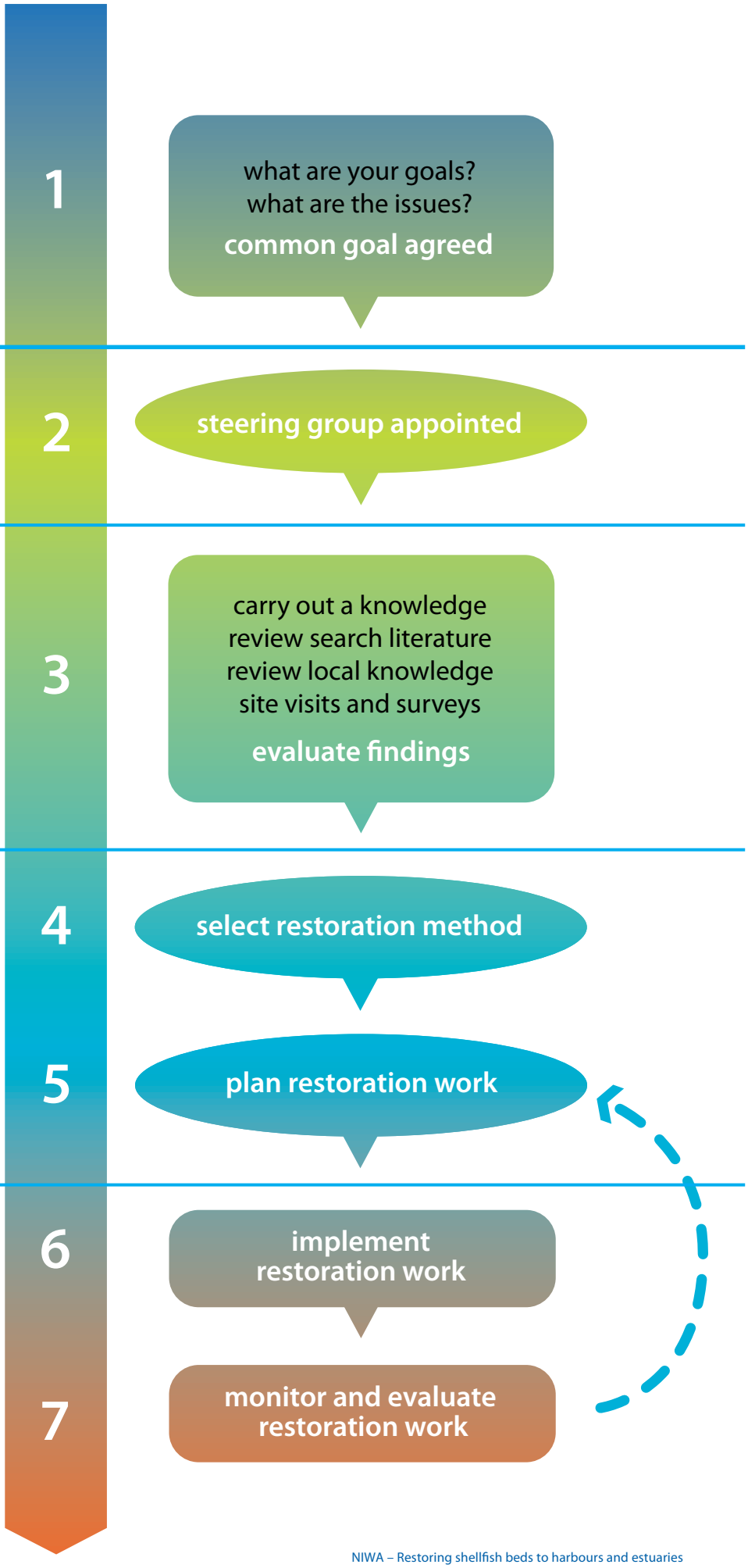
You will need to have more meetings to discuss the findings of the monitoring and review how things are going. Do you need to do anything differently? Does any extra information need to be gathered during the monitoring visits? Are your common goals still valid? These discussions are important in the project's evaluation, in communicating with the wider group (and thus maintaining the ownership of the project), and in keeping momentum up, including looking forward to the next project.

We recommend that you provide summary information to community stakeholders and the general public (possibly through the regional council website) to ensure continued engagement and participation. Regional 'ownership' of restoration projects can significantly contribute to their success.

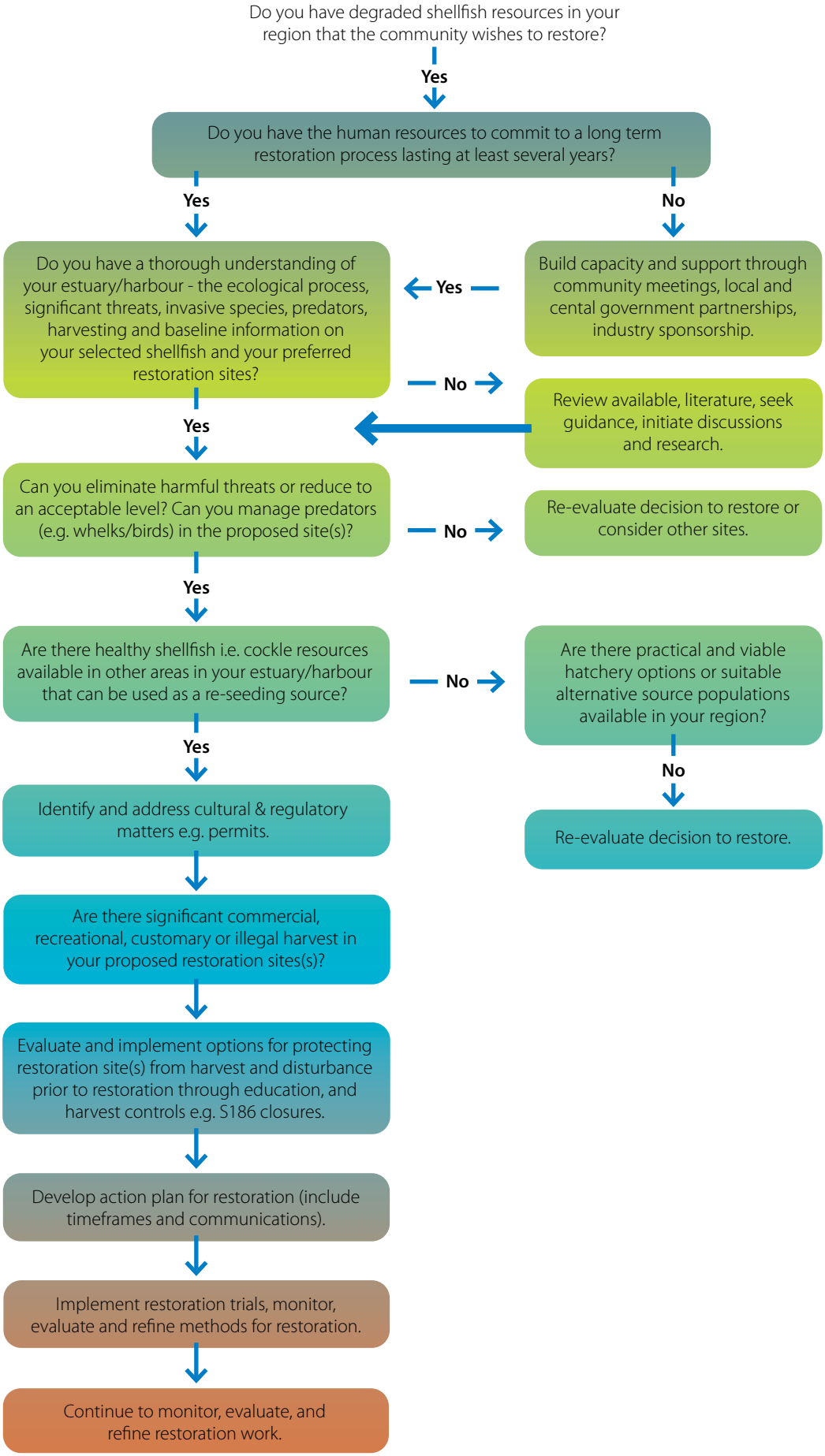
We hope this guide proves useful to those wishing to restore shellfish beds in their own harbours and estuaries, and thus contributes to the continual improvement of New Zealand's coast.

Are you ready to begin a shellfish restoration project?

Shellfish Restoration Project Flow Chart



Shellfish restoration helpful hints



Appendix 1: Equipment useful for work on the harbour/estuary

Personal field gear

- Backpack and/or sleds to get equipment to work site
- Field clothing appropriate for the conditions (e.g., covered shoes or dive boots, wet weather gear, sunscreen, sun hat/glasses, change of clothing)
- Snacks/water for a 4-5 hour work period (thermos of hot drinks if appropriate)
- Watch

Group field gear

- Communications equipment (VHF radio, walkie-talkies, cellphones in waterproof/ sealed plastic bags)
- Instructions (on waterproof paper or inside sealed plastic bags)
- Data recording sheets on waterproof paper
- Clip board
- Pencils (self-propelling mechanical pencils best) and waterproof marker pens (have spares)
- Plastic re-sealable bags
- Camera – to take photos of sites, quadrats and general site characteristics, and to document the volunteers for posterity.
- Emergency gear (flares, first aid kit, rope, blankets/towels, binoculars)

Survey Equipment

- Quadrats, to define area for counting and measuring shellfish. Quadrats can be made from hollow pvc pipe and elbows with holes drilled in the pipe to allow water in and out (see photo); or from meter sticks.
- Callipers, rulers, measuring stick, V-board (only needed if you are measuring shellfish sizes)
- 50 m measuring tape or rope (DIY rope/twine with knots every few meters)
- Spade/trowel
- Buckets
- Sieve
- Squirt bottles (DIY water bottles)
- GPS – (people may have this in their phone or watch)

Appendix 2:

Example monitoring sheet, used by the Whangārei Harbour group for their cockle reseeding project. Marked/unmarked refers to the fact that the reseeded cockles had been marked by the group prior to transplanting. Some of the cockles had been transplanted in cages ('caged/uncaged'), and the reseeding was implemented at two sites ('East/West').

SITE: East / West		Date:	
Measurements made by:			
PLOT: High / Low		**Caged / uncaged:**	Row number:
Species:	**Total No.**	**Measurements (mm):**	**ruler/callipers**
Cockles in plot **Marked** **Unmarked** ? whelks, crabs			
Cockles 0-15 cm **Marked** **Unmarked** ? whelks, crabs			
Cockles 15-30 cm **Marked** **Unmarked** ? whelks, crabs			
Notes:			

Acknowledgments

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Further reading

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http://www.niwa.co.nz/news-and-publications/publications/all/wa/14-1/estuaries (insert date accessed)

http://www.arc.govt.nz/environment/coastal-and-marine/hauraki-gulf-forum/community-shellfish-monitoring.cfm (insert date accessed).[1]

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