CHAPTER 4
BIOSECURITY AND PERMITTING IN SHELLFISH REEF RESTORATION

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KEY POINTS

- **Transfers of shellfish is a major cause of the spread of invasive species and diseases and should be avoided between ecologically different water bodies.**
- **Invasive organisms may result in unpredictable ecosystem alterations in the new environment and may cause negative ecological and economic effects.**
- **The restoration of shellfish reefs has numerous positive ecological benefits, which should not be put at risk from poor biosecurity practices for transfers of shellfish and shell material.**
- **The introduction of non-native species for habitat restoration should be avoided.**
- **Basic rules for successful permitting are: (1) start early, (2) communicate often, (3) involve relevant stakeholders, (4) seek help from experienced shellfish restoration networks.**

Figure 4.1: American slipper limpet (*Crepidula fornicata*). Photo: D.J. McGlashan.

BIOSECURITY

The transfer of aquatic species, such as shellfish, among water bodies has been a major cause of the spread of invasive species, parasites, diseases, bacteria and viruses. The spread of these harmful organisms can have damaging and irreversible ecological impacts, especially where they become serious pests in their new environment. Therefore, taking biosecurity precautions is an obligatory aspect of all shellfish reef restoration where it involves the transfer of shellfish species (or their shells).

A wide range of naturally-occurring pathogens and parasites are associated with marine shellfish, especially with species of oysters and mussels (Bower *et al.* 1994). Such parasites and pathogens are often at low levels and inconspicuous within a native (donor) population of shellfish, making them difficult to detect with confidence, but capable of causing severe effects once transferred into new environments.

In the past, aquaculture and restocking of fisheries was a major source of introductions of aquatic species into new areas. Shellfish reef restoration efforts can now benefit from this past experience and should always strive to apply the best environmental practices and techniques to ensure high biosecurity standards.

INVASIVE SPECIES

Besides parasites and pathogens, there is also a real risk of accidentally introducing other species into new locations when transferring live shellfish and associated material for restoration purposes. The greatest risk of this occurring is from biofouling species catching a ride on the outside of the shells of transferred shellfish. An example of this, is the American slipper limpet (*Crepidula fornicata*) which was unintentionally introduced to Europe in the late 1800s with the import of the American oyster (*Crassostrea virginica*). Today, in parts of Europe the slipper limpet reaches extremely high densities, often smothering the native seafloor community with the large quantities of waste it produces. These limpets may further negatively impact shellfish reef restoration through competition for food and their incidental consumption of shellfish larvae (Figure 4.1).

If the shellfish species intended for transfer is not already present and was not present historically in the proposed restoration site, there is the potential for the introduction of the shellfish to cause unintended ecological disruption. For example, the Pacific oyster (*Crassostrea gigas*) was introduced to Europe for aquaculture in the 1970s and has now established problematic wild populations at various locations throughout Europe. For this reason, the introduction of a shellfish species to an area outside of its natural range should not be considered (Bartley and Minchin 1996).

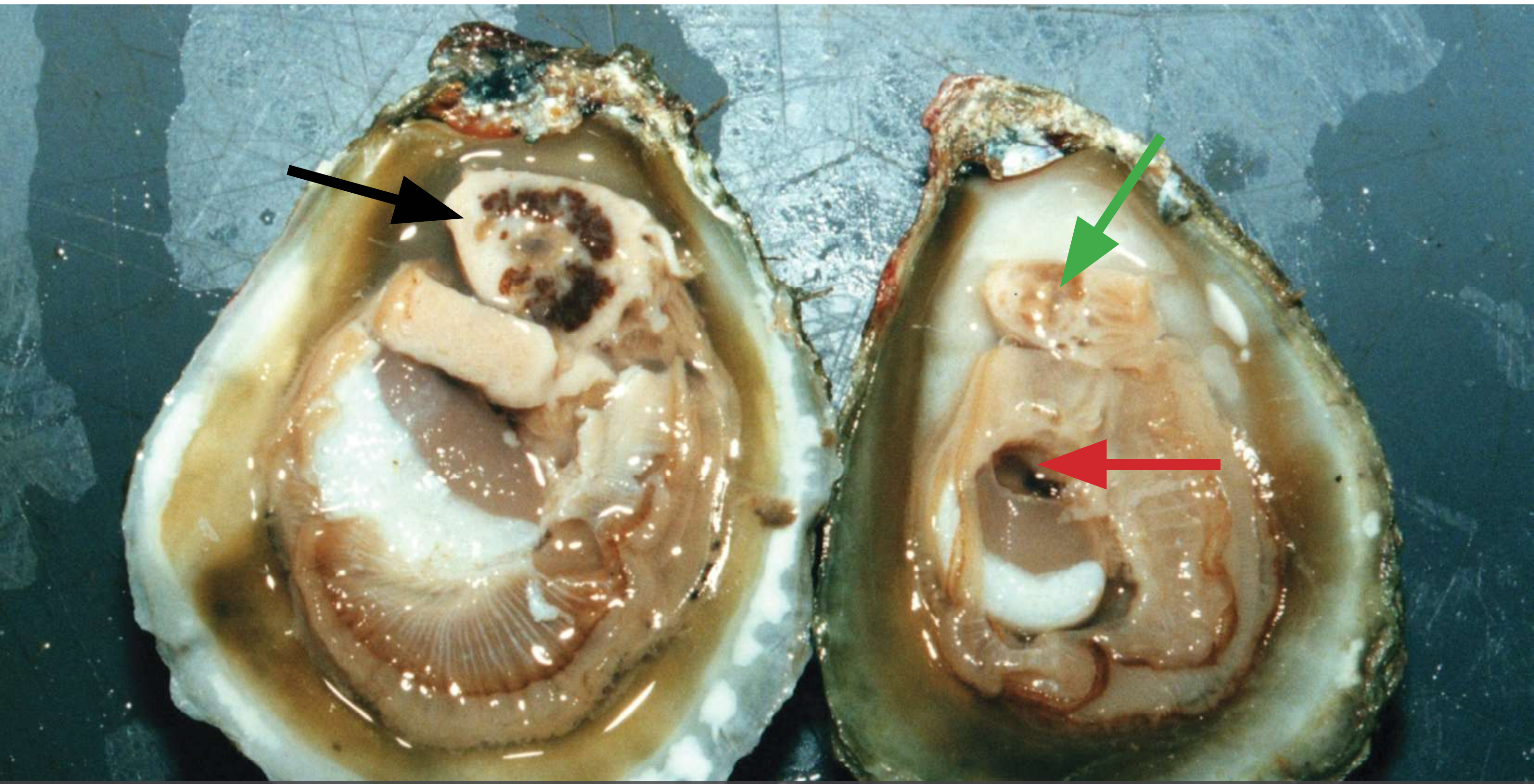

Figure 4.2: Bonamiosis in Bluff Oysters (*Ostrea chilensis*). The oyster on the left appears healthy with a dark digestive gland and normal sized gonad (black arrow). The oyster on the right is infected with *Bonamia exitiosus*. It has a gonad and digestive gland which are comparatively small and pale (green arrow), and an enlarged heart (red arrow). Photo: Ben Diggles.

PARASITES AND DISEASES

Historically the accidental introductions of shellfish parasites and pathogens have occurred in concert with the transfer of shellfish or shell material deployed in efforts to improve shellfish harvests. This has frequently caused massive financial losses from damage to commercially important shellfish populations across large areas.

For example, a virulent microbial parasite of flat oysters, *Bonamia ostreae*, was transferred with oysters from the Pacific Coast of North America to France, resulting in widespread and ongoing losses of farmed oysters, especially in northern Europe. Initial losses in some oyster populations due to the introduced disease were almost 80%, indicating the vulnerability of shellfish to pests for which they have no natural resistance. Similar impacts have been observed in *Ostrea chilensis* in New Zealand (Figure 4.2).

Similarly, a virulent herpes virus is the cause of Pacific oyster mortality syndrome (POMS) which caused significant losses in the Pacific oyster aquaculture industry after it first appeared in New South Wales, Australia, in 2010. The viral disease was subsequently transferred to the island state of Tasmania in 2015, causing mass Pacific oyster mortalities (>60%) and closing down the export of seed oysters from the state, which supported the oyster aquaculture industry in other regions of Australia.

Once a pest species is introduced into a new location in the marine environment it is extremely difficult, if not impossible, to eradicate.

Therefore, preventing introductions of pest species when transferring shellfish and other material, such as shell cultch, among locations is vitally important.

In areas targeted for restoration that may already have shellfish diseases or parasites present, it is important to identify populations of shellfish for sourcing broodstock or for transfer that are resistant to these pests to help ensure the survival of the shellfish following their transfer, if at all possible. Surviving shellfish in areas that have displayed the highest disease loads, for the longest period, are most likely to have developed the greatest tolerance to the disease. However, it is also important to avoid transporting the pathogens responsible for the disease to new areas. Producing disease-free stock that carry the available genetic tolerance, but are free of pathogens, is an important consideration for shellfish transfers in areas affected by diseases.

Increasingly, shellfish hatcheries are playing a role in developing and producing certified disease-free stock that is particularly effective for reducing the risk of spreading shellfish diseases.

Transferring large numbers of the shellfish species targeted for reef restoration into new areas has the potential to alter the genetic diversity and local adaptation of the existing native population in the receiving areas. Subsequent genetic mixing of the two groups may decrease the fitness of the genetically mixed population.

For example, strains of the American oyster that have been selectively bred for disease resistance have been found to have the highest growth and survival in their natal region. These benefits tend to decrease with increasing distance from that natal region. Transferring these oysters into more distant locations where they can interbreed with an existing resident population of oysters may ultimately result in the dilution of the local adaptation among the resulting oysters to the environmental conditions in the area.

In some areas, e.g. southern Australia and Europe, the native population of shellfish has been driven to local extinction, so sourcing locally-adapted broodstock is not an option.

Where possible, it is always preferable to work with local shellfish populations as the basis for restoration because it eliminates the risk of accidental introductions of shellfish pests and genetic interference. High resolution scientific studies of the genetic structure of shellfish populations are the best guide to determining possible differences between the intended source and receiving populations for shellfish reef restoration. In the absence of information on population genetics, wild shellfish populations from the same geographic region and connected by an immediately contiguous water body should be used where possible. If the transfer of shellfish between more distant locations is required for restoration, it needs to be carefully assessed before proceeding.

In some jurisdictions this careful assessment is a mandated requirement, which may also entail formal permitting considerations by a managing agency or assessment by a regional biosecurity agency. Even if it is not a mandated requirement, an assessment is advisable to avoid the risk of the shellfish transfers doing more environmental harm than good through accidental introductions of parasites or diseases.

Typically, such an assessment will involve an expert appraisal of any potential risks of negative effects of a transfer of shellfish, usually involving a comparison between the profiles of the presence of parasites and diseases at the source and receiving locations for the planned transfer of shellfish for the restoration. Finding suitable expertise in shellfish diseases and parasites, especially for community-driven shellfish restoration initiatives, may be challenging, however, such people are often found in regulatory agencies, universities, and other aquatic research institutions. If regulatory agencies are unable to provide guidance, then asking around among aquatic researchers will often provide direction to appropriate expertise that can be of help.

An assessment may result in protocols for shellfish transfers that are aimed at minimising any associated risks due to shellfish transfers (e.g., ICES 2008; CEFAS 2009). Protocols used in assessment may involve prior testing of shellfish to confirm pest-free status, treatment of transferred shellfish prior to their release into their destination location (to destroy organisms living on or in the shells of shellfish), or the banning of movements of shellfish from known disease regions to currently disease-free areas.

This is currently the situation with restrictions on movement of oysters across regions of Europe and parts of Australasia where the flat oyster parasite *Bonamia* is known to be present.

Where translocations of shellfish are allowed, dipping or spraying shellfish with freshwater or weak acetic acid (vinegar solution) has been used to destroy biofouling pest species, such as invasive sea squirts, seaweeds, and fan worms, to prevent their transfer among locations.

The movement and placement of shell-based cultch material bears some similar risks to those associated with the movement of live shellfish. Untreated shell material, collected as part of shell recycling initiatives, may contain living pests or spores and should therefore also be subject to biocontrol measures before being deployed.

While regulations vary, heat treatment, chlorine treatment, immersing in freshwater for extended periods or weathering outdoors for a period to ensure all hitch-hiker species and pathogens on shell material have been destroyed or reduced to acceptable levels, greatly reduces the risk of inadvertently transferring pest species. Where large volumes of shell are involved, weathering at an inland site may be the only cost effective approach unless the shell is a by-product of shellfish processing involving sufficient heat treatment. For shell weathering, six months is a commonly used minimum weathering time. For example, the Rhode Island Biosecurity Board stipulates six months weathering of shell material with turning of the pile every second month for a thin layer of shell material (<6 inches, 15 cm) and up to twice a month for a deeper layer of shell material (Figure 4.3). The requirement to turn the pile would be less frequent in warm climates.

Whilst complying with such measures may appear to create additional complexities or hurdles for shellfish restoration they should not be overlooked because the long-term ecological and reputational consequences of an accidental introduction may greatly outweigh the benefits of local shellfish reef restoration.

PERMITTING

Of the many components of a successful restoration project, it is the time and diligence involved in permitting that often tends to be underestimated. Permits in many jurisdictions are provided by natural resource management agencies who are charged with protecting the resource on behalf of the public and considering all possible interactions resulting from the restoration. Navigating the permitting process requires a thorough understanding of the project and the restoration process for both the applicants and the permit reviewers.

Complications can arise in the permitting process. While those in the restoration community are often immersed in the process and in quantifying the benefits of the restored habitat, those in the regulatory agencies may have little familiarity with marine habitat restoration. In this situation, completing an application with tables of information is likely to be insufficient and consideration should be given to communicating specific restoration aims and benefits in greater detail to the regulators.

Figure 4.3: Community members preparing a pile of cured recycled shells for deployment in Rhode Island, USA. Photo: John Torgan.

Involving overarching restoration networks with prior experience of dealing with regulatory agencies and the concerns these agencies may have, can help to facilitate the regulatory acceptance of restoration.

Frequently, in areas where shellfish reef restoration has not previously been undertaken, there may be uncertainty among regulatory agencies regarding who has the authority to grant a permit, or even how many agencies will need to provide their permission. Jurisdiction generally depends on the category of the selected restoration site and the existing management regime within the site (e.g., coastal waters, offshore waters, marine protected areas, multi-use areas, and fishing grounds).

There is rarely a category of 'restoration' permit available because this type of activity has only emerged in relatively recent times. This means that, at least initially, restoration is likely to be permitted under an existing category that is considered similar or that deals with different aspects of the proposed restoration activity. These permitting processes tend to relate to other activities such as aquaculture, fisheries, biosecurity or marine construction.

In the USA, with a longer history of shellfish reef restoration projects, the permitting process was sufficiently complex and varied across the country that The Nature Conservancy commissioned an inventory of shellfish restoration permitting for the 21 coastal states (Mississippi-Alabama Sea Grant Legal Program and National Sea Grant Law Center 2014). This inventory describes the regulatory environment that may affect shellfish reef restoration in each state, under five broad categories and encompassing 18 different sub-categories – indicating the extent of differences in the regulatory regimes affecting shellfish reef restoration activities across the USA.

Practitioners must endeavour to educate themselves about the regulatory process and educate regulators in the history and benefits of shellfish reef restoration, as well as the project to be permitted. In the absence of familiarity with the permitting environment the basic rules are:

1. Start early
2. Communicate often
3. Involve relevant stakeholders
4. Seek help from experienced shellfish restoration networks.

In jurisdictions where shellfish reef restoration is a new and unfamiliar activity, it is beneficial to involve staff of the regulatory agencies in the restoration project, along with other stakeholders, from the outset with the initial planning and concept development phase. Providing a clear picture of the reference ecosystem or model for which the restoration project is working towards (see Chapter 3) may assist with communicating to regulators what the future intended state of the restoration site(s) will look like.

One consideration that routinely arises in the design and permitting stages is whether subsequent harvest of the shellfish will be allowed within the restoration area. Overharvest of shellfish has been the primary threat leading to the drastic decline of shellfish populations, and yet many jurisdictions often do not have the legislative framework to close off a restoration site to subsequent harvest, even where an objective of shellfish reef restoration is to provide an increased supply of larvae to enhance recruitment to nearby fishery resources. It is important to determine the legal and social frameworks for managing fishing within the restoration project's boundaries so that the integrity of the shellfish restoration effort can be maintained.

In some jurisdictions there will be groups or individuals from which additional approvals may need to be sought, and the process may not be as straightforward as filing a written application with a government agency. For example, indigenous stakeholders in many regions of the world maintain both historical and/or legally mandated jurisdiction over coastal resources, which may include customary title or preferential access rights to tidal lands and shellfish. Due to strong historical association with coastal resources, indigenous stakeholders frequently have a high degree of knowledge of shellfish resources and are often valuable sources of information and can be strong allies in support of restoration efforts. Consulting with indigenous stakeholders early and maintaining dialogue and engagement throughout coastal restoration initiatives is often a key to success.

Other groups in the community that may be affected by a restoration initiative also need to be identified early and consulted. This may include commercial and recreational fishers, tidal land owners or leaseholders, or aquaculture operators. Promoting open dialogue with all interested groups in the community will often strengthen support for the restoration initiative, improve its design and acceptance, while also raising public awareness and promoting more active engagement around tackling threats to our coastal environments.

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