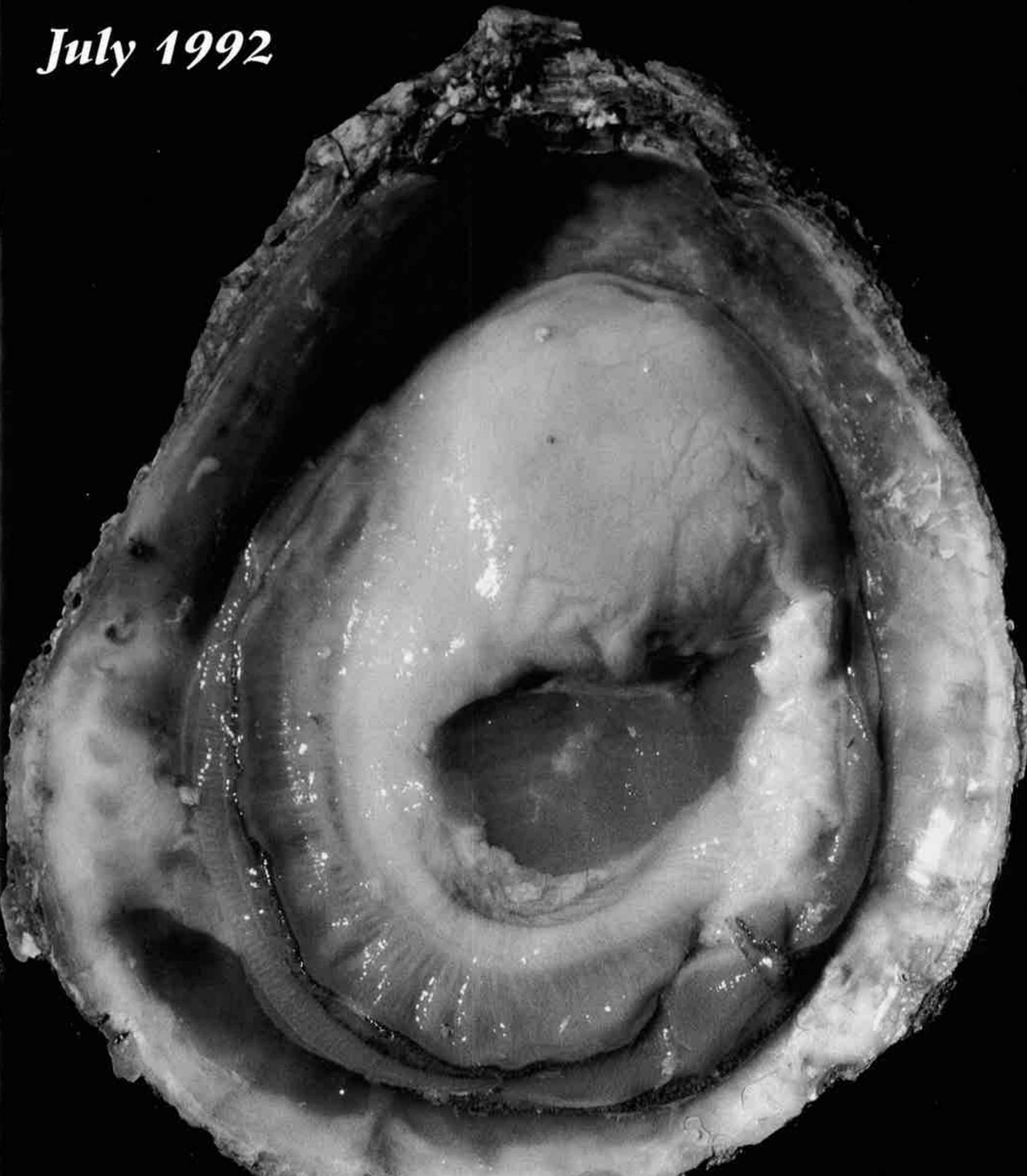
Farming the dredge oyster

proceedings of a workshop

July 1992



New Zealand Fisheries
Occasional Publication No. 7

ISSN 0113-227X
1992

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New Zealand Fisheries
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Published by MAF Fisheries
Wellington
1992

ISBN 0-477-08665-9

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MAF Fisheries is the fisheries business group of the New Zealand Ministry of Agriculture and Fisheries. The name MAF Fisheries was formalised on 1 November 1989 and replaced MAFFish, which was established on 1 April 1987. MAFFish combined the functions of the old Fisheries Research Division and Fisheries Management Division and the fisheries functions of the old Economics Division.

The *New Zealand Fisheries Occasional Publication* series in part continues the *Fisheries Research Division Occasional Publication* series. It will contain mainly bibliographies and conference proceedings. Other material of a kind previously published in the *Fisheries Research Division Occasional Publication* series is now published in the *New Zealand Fisheries Technical Report* series.

Set in 10 on 11 Times Roman
Typeset by Challis Datacom
Printed by Brooker and Friend Ltd.

A 1 day workshop to discuss the prospects for farming the dredge oyster, *Tiostrea chilensis*, was held at MAF Fisheries Greta Point, Wellington, on 17 July 1992.

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Introduction

P. J. Smith

MAF Fisheries Greta Point

The dredge or flat oyster *Tiostrea chilensis* has occupied a niche market in New Zealand for many years. Most oysters have come from the Foveaux Strait fishery, with smaller volumes from Tasman Bay. Over the past few years the parasite *Bonamia* has had a major impact on the oyster beds in Foveaux Strait, severely reducing the stocks. The quota has been cut from 115 000 sacks in 1986 to 46 000 in 1991, catch rates have dropped by about 50% over the same time, and the fished area has declined. In Europe stocks of the flat oyster *Ostrea edulis* have been decimated by a similar parasite, and there is a major shortfall in flat oyster production. Thus, there appear to be good market opportunities for farmed dredge oysters, both in New Zealand and in Europe.

Dredge oysters have biological attributes which make them a favourable candidate for aquaculture: they are native to New Zealand and can be ongrown under low technology systems. However, *Bonamia* may be a double-edged sword. It has created the market opportunity, but equally it may infect farmed as well as wild oysters. Apart from disease problems, there will be other problems in developing dredge oyster farming, as there are in setting up any new industry. These problems may be technical, such as how and where to produce spat or how to ongrow stock; they may be legislative, such as site restrictions or public health requirements; or they may be market oriented, such as product presentation or overseas competition.

The aim of this workshop is to discuss the prospects for farming the dredge oyster, to evaluate opportunities and associated problems, and to provide an indication of the requirements to develop this industry. Contributors with specialist expertise have been invited to give overviews on issues covering licensing, conservation, export and health, disease, spat production, ongrowing, and marketing. In addition, key industry personnel with skills and experience in aquaculture, processing, and marketing have been invited to contribute to the workshop. Papers from contributors, and summaries of the discussion sessions, are included in the workshop proceedings.

Ngai Tahu perspective

R. C. T. Manning

Ngai Tahu Fisheries Limited, Wellington

Kaupapa

Ngai Tahu seeks a position in the future of the dredge oyster industry on whatever basis emerges from the Maori Fisheries Act and subsequent negotiation. At this stage that means 10% of the future resource ownership and management. If the structural arrangement of the industry is broadly similar to that of the Nelson scallop industry, Ngai Tahu sees no particular difficulty in that.

Ngai Tahu will recognise the structural issues and problems facing the dredge oyster industry, and we are not keen to do anything in pursuit of the tribe's overall treaty rights which will further complicate matters. For a start, there are too many relations involved! Nevertheless, it is the Ngai Tahu longterm intent to become a participant.

Redevelopment of new beds raises unresolved issues of coastal zone sea bed harvesting rights and the related issues of investor and non-investor exclusion. These issues apply to other sedentary fisheries and will be affected by current Ngai Tahu negotiations with the Crown.

The broad position that Ngai Tahu has adopted is similar to that of the wider fishing industry, and that is that those who invest in stock enhancement or redevelopment of species on the sea bed and in the coastal zone should have an exclusive right of harvest. Ngai Tahu regards the present situation in that respect as totally unsatisfactory.

The Resource Management Act has reduced the capacity of the Crown to ensure investor or harvesting rights. Before the Act the Crown was able to lease areas of sea bed to investors, but that is not now possible, and there are many legal and statutory questions as to who actually has authority and control. Structures built on the sea bed in the coastal zone are within the control of the regional councils, but the rights to the bed and the capacity for exclusion of others are not clear.

Neither is the present Fisheries Act much help in terms of marine farming applications once one moves away from the land's edge, and the nature and extent of the authority over the sea bed is a hopeless mix of regional government, MAF Fisheries, DoC, and general Crown authority. The shambolic situation with regards to our estuarine zones applies equally, if not more so, to the sea bed beyond the shore. The Ngai Tahu negotiators and the Maori fisheries negotiators have paid considerable attention to this, and so far all I can say is that they have highlighted the problems. It is the view of Ngai Tahu that the biological and scientific issues of stock recovery or enhancement are straightforward in comparison with the manmade legal disaster which will underpin any practical recovery model.

Ngai Tahu believes that it may take some time to work through the final application of treaty rights in the coastal zone, not because they are difficult to state or identify in terms of the courts and tribunals, but because the real problem is the statutory tangle that has been created by Parliamentary and Crown incompetence.

Ngai Tahu may, if suitable opportunities arise, purchase a greater stake in the dredge oyster industry, over and above that which comes to it by means of Maori fisheries legislation. That will depend on Ngai Tahu's future capital position and the outcome of the overall Ngai Tahu claim negotiations. The industry is recognised by Ngai Tahu as being particularly important for our own people living in Bluff and Murihiku, and a position in it is clearly a significant aspect of the Ngai Tahu employment future.

Ngai Tahu's interest in marine farming and enhancement of stock discontinued once commercialisation with no controls became evident. Our old people gave away the practice because they saw it as merely feathering someone else's nest. The oyster farm in Oyster Cove was a prime example of a kohanga (nursery) becoming depleted very early in the piece. Taiapure coastal zones may, if applications are approved, provide Ngai Tahu with an initial opportunity to apply some traditional practices of stock enhancement known to our tribe and retained by a few.

Spat production

R. W. Hickman

MAF Fisheries Greta Point

Last week while I was waiting in the local fish shop for my groper fillet to fry, three out of the next five customers ordered oysters and chips. All received the same reply "Sorry mate, no oysters, don't know when we'll see any more of them!" With these terse words the fishmonger brought into focus several points that relate directly to this workshop. Firstly, flat oysters, dredge oysters, Bluff, Foveaux Strait, Stewart Island, or Nelson oysters (call them what you will) are a very popular New Zealand delicacy. They have always been cheap — 13 cents an oyster was the landed value in 1988 — and always plentiful — 3 dozen oysters for every man, woman, and child in New Zealand when the Foveaux Strait fishery was at its peak. Secondly, dredge oysters are unfortunately no longer plentiful — *Bonamia* has contributed to an 80% reduction in the Foveaux Strait stock — and as a result they are no longer cheap — 50 cents an oyster landed value, or up to $1.00 each for cooked oysters was being quoted at the start of this year's season. Thirdly, oysters are no longer the inexpensive family meal they used to be in New Zealand, but neither have they become the gourmet food item of, for example, Britain, where £2 each is not uncommon in London's oyster bars.

Spat is the term used for oysters as soon as they have settled, and spat production may hold the key to whether New Zealanders can continue to enjoy their dredge oysters and whether a flat oyster farming industry here can grab a share of the lucrative European market.

Overseas hatchery techniques must be adapted to suit our dredge oyster, and I will describe what are likely to be the main problems in achieving commercial scale spat production with our species. I will use results from our research at the Mahanga Bay hatchery to illustrate the problems and to suggest solutions. What I won't be doing is to provide a detailed recipe for dredge oyster spat production. That would take more time than I have available, and it is the basis of a technical report being finalised.

There are well established and well documented techniques for the production of spat of other flat oysters, particularly the European species *Ostrea edulis* (*see* Walne 1974, Wilson 1981, Utting & Spencer 1991). *Ostrea edulis* spat of various grades, ranging in size from 5 to 20 mm, can be purchased from several commercial hatcheries in Europe and North America.

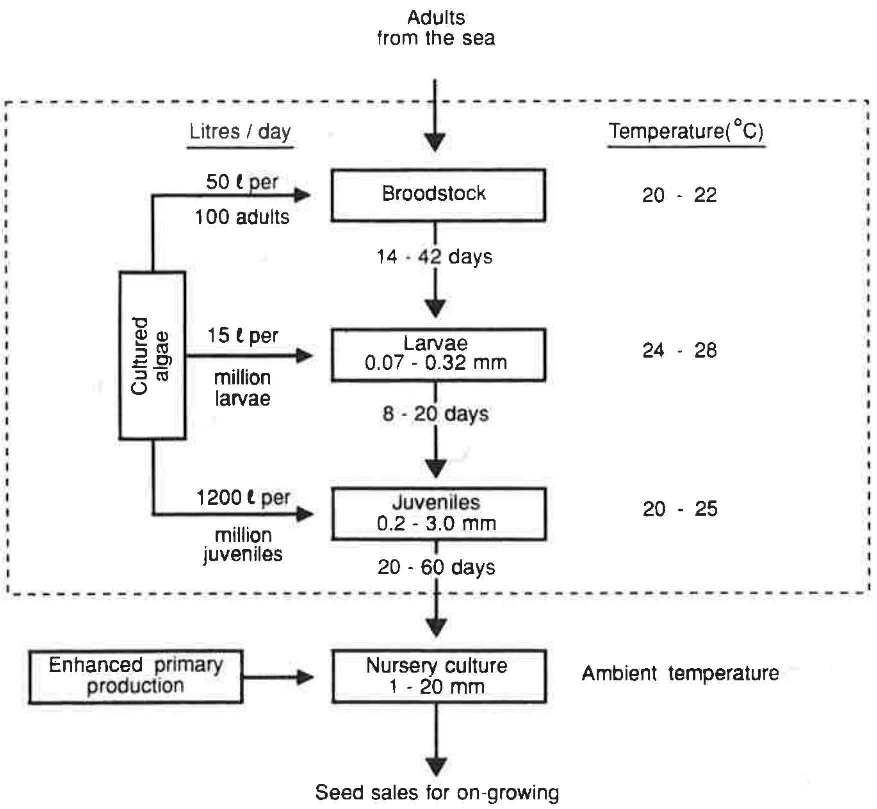
There are three stages in spat production: broodstock conditioning; larval rearing, which ends at settlement; and ongrowing of the settled spat (also called seed or juveniles) (Figure 1). This third stage usually involves both a hatchery and (as the spat increase in size) an outdoor nursery.

There are problems unique to the dredge oyster in each of these production stages. A broodstock conditioning system for the European oyster is shown in Figure 2. It comprises 50–60 adult oysters in a tank with a constant supply of sea water and an additional supply of food in the form of cultured microalgae. There is a major difference in the reproductive behaviour of flat oysters *Ostrea* spp. and cupped oysters *Crassostrea* spp. Cupped oysters spawn their eggs and sperm into the water for external fertilisation and larval development. Flat oysters retain their eggs in the shell of the parent. Fertilisation occurs internally, and the larvae are incubated in the mantle cavity for at least part of their development.

The unique feature of our oyster species is its habit of incubating its larvae right through their development, so that at release they are ready to settle immediately. Other flat oysters release their larvae at a much earlier stage, when they still have 1–2 weeks of free-swimming development before they are ready to settle. Early release means the larvae can be easily collected in the outflow water from the broodstock tank (inset Figure 2) and they can then be transferred to the second production stage, the larval rearing. Dredge oyster larvae on the other hand are quite likely to settle on the floor and walls of the broodstock tank and all over the adult oysters.

Because of the extended incubation period in dredge oysters, the number of larvae incubated is relatively low: a Pacific oyster might release 50 million eggs and a European oyster might release 1–2 million larvae, but our oyster only incubates between 20 000 and 120 000 larvae, an average of 50 000 for a typical 60 mm diameter commercial sized oyster. This low figure has a major bearing on the numbers of broodstock required for spat production, as does the naturally low level of incubation in the dredge oyster. In a sample from a wild population it would be unusual to find more than 5% incubating, and only 6–12% of the adult population in Foveaux Strait may incubate during the season (Cranfield & Allen 1977).

Swimming larvae are collected in a sieve and transferred to the larval rearing tank (Figure 3). The tank can be almost any size and shape to suit the scale of production, but it will contain filtered sea water, which is temperature controlled, aerated, and supplied with microalgal food for the larvae. It is also capable of being drained regularly. In this system the larvae grow and develop until they are ready to settle. Settlement is achieved either by hanging solid substrate, usually plastic strips or bags of clean shell, in the larval rearing tank or by pouring the larvae on to a layer of particulate substrate — finely ground oyster or scallop shell.



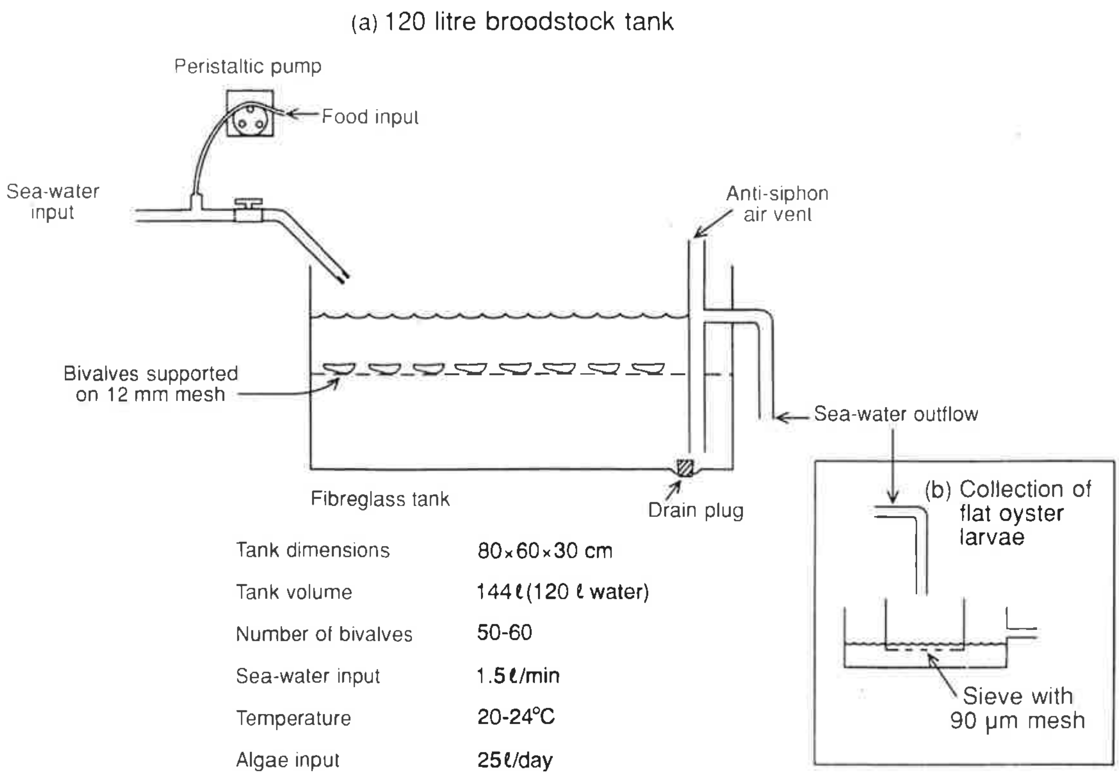


Figure 2: A broodstock conditioning system (© British Crown copyright 1991, reproduced from Utting & Spencer 1991).

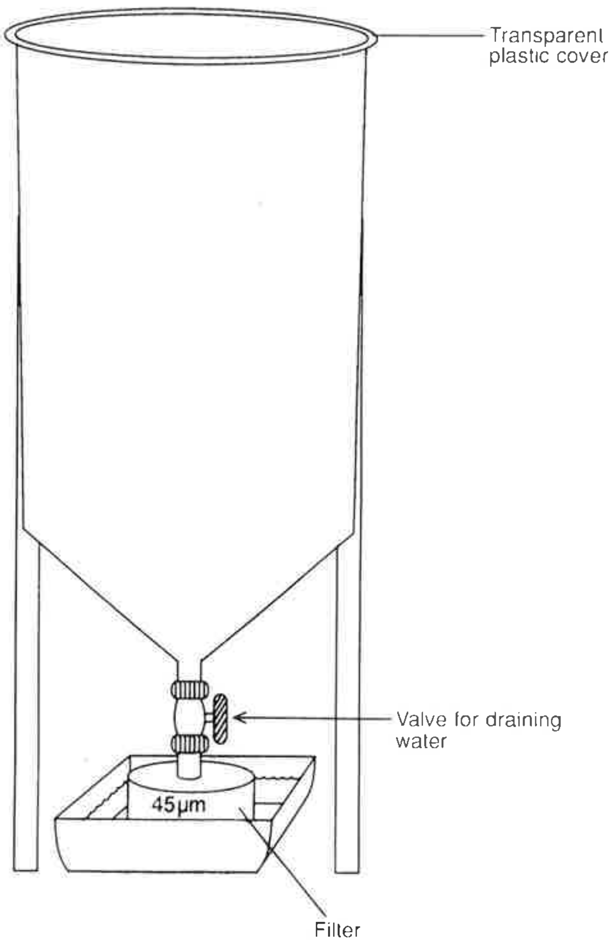


Figure 3: A larval rearing tank (© British Crown copyright 1991, reproduced from Utting & Spencer 1991).

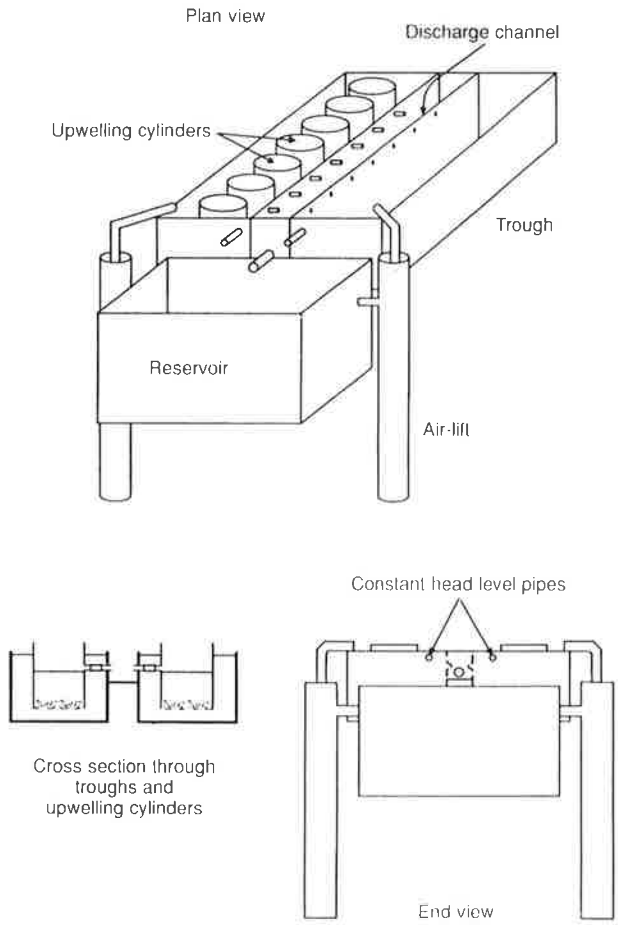


Figure 4: An upwelling spat ongrowing system (© British Crown copyright 1991, reproduced from Utting & Spencer 1991).

It may be possible to eliminate the larval rearing stage for our dredge oyster and achieve settlement at the end of broodstock conditioning. Once the larvae have settled they are called spat or seed and can be transferred to the third production stage for ongrowing (Figure 4). Spat on solid substrate can be moved directly to a farm. Spat on particulate substrate (often called culch-free or single seed) are placed in an upwelling system. Mesh-bottomed cylinders hold the spat (at high density) and an upward flow of water through the cylinder provides the spat with their food. Flow-through or recirculating systems are possible. Hatchery-based upwelling systems are usually fully or partially recirculating to make optimum use of the cultured microalgae which are added to the system to maintain rapid growth of the spat. A successful upwelling system requires a combination of water flow, food input, and spat biomass appropriate to the total volume of the system. Guideline figures for these parameters are available for overseas species (*see* Walne 1974, Wilson 1981, Utting & Spencer 1991).

Once the spat or seed reach 2–3 mm, their food requirements become too great to be supplied by algal culture, and they are transferred to outdoor nursery culture, which may be land-based, in flow-through upwellers or raceways, or a floating container system in the sea.

During this ongrowing stage the major problem is culturing sufficient food to satisfy the ever increasing requirements of the rapidly growing spat. Choosing the best mixture of algal species, and supplying the optimum ration of food, for the particular oyster species being reared are critical to obtaining the fastest growth of the spat. Regular changing of the water, in recirculatory systems, with frequent washing and size grading of the spat, will benefit both growth and survival. However, we have been growing a settlement of about 150 000 spat in an upwelling system at Mahanga Bay using only sea water as the food supply. After 4.5 months in this system about 7% by number (35% by weight) were 5–10 mm, 39% (47% by weight) were 2.5–5.0 mm, and 54% (18% by weight) were still only 1.0–2.5 mm. This is a slow growth rate, but it provides a baseline for what might be possible in a low technology hatchery without an algal culture facility. From earlier experiments we could expect to about double the growth rate by providing microalgae to supplement the food supply (Figure 5). One feature of the upwelling system is the almost negligible mortality rate.

I have said that 2–3 mm was about the maximum size for spat culture in a hatchery, and that various nursery systems had been developed to take the spat through to, say, 20 mm. For low technology spat production of dredge oysters, the spat would need to be taken from the hatchery as soon as possible, so we developed a "pump pot" nursery system for Mahanga Bay (Figure 6). This is a commercially manufactured drainage fitting which has been modified to form a pot with a mesh bottom and slits in the top. It can be hung from the raft in Mahanga Bay, and with the constant rise and fall of the raft caused by wave action, water is pumped up through the pot and past the spat, which lie on the mesh. These pots can hold more than 3000 spat of 2–3 mm, and we have grown spat to over 40 mm diameter in pump pots — but at much lower density.

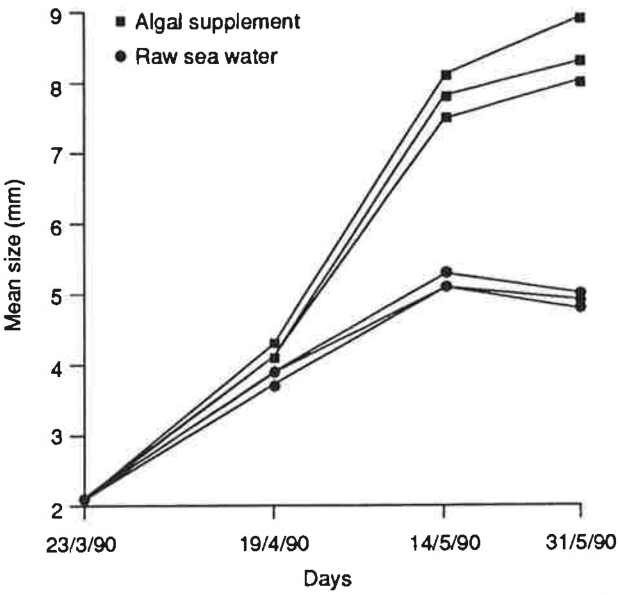


Figure 5: Growth of spat in upwellers supplied with raw sea water and sea water supplemented with algal culture.

Our best growth at Mahanga Bay was for spat grown for 3 months in an upweller to about 10 mm, followed by 1.5 months in a pump pot to reach 18 mm, and subsequently 9 months in a pearl net to a mean size of 43 mm. Thus, commercial size would have been reached well within 2 years.

Finally, I'd like to examine the spat or seed production requirements of a hypothetical dredge oyster farm. I'm going to assume the oysters will be grown attached to vertical tapes (a method that I looked at recently in Australia), with the tapes suspended on longlines in mussel farming style. The oysters are attached every centimetre, so there are 500 oysters per 5 m length of tape (which is the equivalent of the mussel rope). If we further assume 400 tapes per longline and 10 longlines for the farm, then the total number of seed required to stock the farm is 2 million (500 x 400 x 10).

The production of 2 million seed of 20–30 mm, a size suitable for attaching to tape, is outlined under two scenarios in Table 1.

Working backwards from the required number of seed: (1) if we assume a 10% mortality during the postsettlement ongrowing period, 2 200 000 settled spat would be required; and (2) with a 50% settlement success rate, 4 400 000 larvae would be required; and (3) at the average figure of 50 000 larvae per brood, 88 incubators would be needed; to obtain this number of incubating oysters from a wild population, we must assume that (4) only 15% of those oysters incubating would have larvae which were ready to settle (the rest of the brood would be at too early a stage of development), so 586 incubators (of all developmental stages) would be required. However, because (5) only 5% of a wild population would be likely to be incubating, 11 720 broodstock would be needed to provide the necessary incubators to produce the 2 million seed to stock one farm.

However, our research has shown that by using hatchery production techniques the figures in this

Figure 6: Mahanga Bay "pump pot" nursery system.

Table 1: Spat (seed) requirements for a dredge oyster farm producing 2 million 20–30 mm seed under scenarios of normal expectation and use of advanced hatchery technique

	Scenario 1			Scenario 2		
Assumption	%	Requirement		%	Requirement	
1. Postsettlement mortality	10	2 200 000	settled spat	5	2 100 000	settled spat
2. Settlement success	50	4 400 000	larvae	75	2 800 000	larvae
3. 50 000 larvae per brood		88	incubators		56	incubators
4. Broods ready to settle	15	586	incubators	100	56	incubators
5. Incubation rate	5	11 720	broodstock	20	280	broodstock

scenario can be changed dramatically. By broodstock manipulation it will be possible to get much higher incubation rates — we have had up to 15% by just holding the broodstock in suspension on our raft — and incubation rates as high as 40–50% may be possible. Very high settlement rates are also achievable — up to 75% or even 90% — as is very low postsettlement mortality.

Thus, if we work through the same oyster farm with scenario 2, with a second set of assumptions, which I believe on the basis of our work to be more realistic: for the same seed requirements of 2 000 000, if the postsettlement mortality were reduced by half to 5%, the settled spat requirement would be 2 100 000; which, with 75% settlement, would require 2 800 000 larvae; and at the same 50 000 larvae per brood, this would mean 56 incubators. By use of our broodstock conditioning and holding techniques, all the incubators should produce larvae which were ready to settle, so we would not need to further adjust the number of incubators. Finally, with an increase in incubation rate to, say, 20%, the final figure for the numbers of broodstock required to supply the farm with 2 million seed would be only 280.

Selection of larger size oysters for the broodstock could increase the average brood size from 50 000 to 75 000, which would reduce the number of broodstock required to only 187 oysters.

In summary, controlled spat production in a hatchery is necessary to avoid the problems of small brood size and low numbers of incubators, which characterise our dredge oyster. Once settled spat have been obtained, standard production techniques can be used to grow the spat to a size suitable for supply to a farmer, with very high survival and with a growth rate which is highly dependent on food supply.

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Discussion

Manning asked about the incubation time and the ideal incubation temperature. Hickman replied that they weren't sure, but they estimated 21–30 days, probably temperature dependent. At Mahanga Bay they worked at ambient (> 15 °C), whereas the ideal temperature in a hatchery would be 20–25 °C. Higher temperatures may decrease brood time and increase larval development.

Jenkins asked about culture of other oyster species overseas? Hickman said that the Australian oyster *Ostrea edulis* had a large broodstock (1–2 million, about three times the dredge oyster). Free swimming larvae were easier to get into larval rearing tanks, whereas ours settle rapidly and will settle all over the tank and other oysters. They need to be settled on the right substrate, or the release of larvae must be controlled. The only other oyster like ours is the Chilean, but there are no commercial hatcheries for that species in Chile.

Dawber queried whether there had been any work done on salinity and other factors. Hickman said that they hadn't looked at it because they used a low technology system, with minimal manipulation of the environment. Water temperature and amount of food were the critical factors, and a hatchery site needed to be near a farm, because the water may be more or less productive.

Hearn asked for comment on pre- and postsettlement survival. He felt that postsettlement survival was the key issue with mussels; he had had very good settlement, but 100% subsequent mortality. Hickman replied that it was difficult to comment because they were dealing with few (150 000) animals at Mahanga Bay. They had held them in 8″ (20 cm) upwellers at high densities (20 000–50 000) with negligible (< 1%) mortality, but with very low growth rates. They had achieved up to 75% settlement and didn't see postsettlement survival as being a major problem.

Hay asked whether there had been any work done on increasing incubation rates. Hickman said that they got 10–15% incubation rates after transferring broodstock from the bottom to suspended culture on rafts. They tried inducing fertilisation by using sperm stripped from other oysters, but got variable and unreliable results. He said that they needed to do more work on methods of manipulating fertilisation, but up to 50% incubation rates may be possible.

Ongrowing

L. Curtin

MAF Fisheries North, Auckland

Basic considerations

When considering ongrowing methods there is no reason to assume that the growing of the dredge oyster by private individuals will not need to meet the three basic requirements for any private marine farming/growing/enhancing venture; viz,

- it must be politically possible;
- it must be biologically possible;
- it must be financially possible (that is, profitable).

Political possibility

It would be fairly simple to adopt the ongrowing method of seeding suitable bottom areas with spat, at the density found in the natural fishery, and leaving them to grow to maturity before being recovered by dredge. However, this would require the use of areas far larger than those presently occupied by private individuals to grow various marine species.

The fisheries legislation makes no provision for this type of activity to be undertaken as a full commercial operation. It is difficult to see regional authorities granting consents under the Resource Management Act over such large areas for anyone to occupy the area to the exclusion of others. Applications under the RMA for areas over 10 ha are processed via the Department of Conservation (DoC). The department is required to pursue its responsibilities as it sees fit; it is not required to agree with every marine farming/growing/enhancing proposal made under the RMA.

Unless there is a radical revision of the present legislation, private ongrowing methods will have to extend beyond a mere attempted reproduction of the natural fishery. They will need to make the most efficient use of whatever ground might be made available.

Biological possibility

Our second consideration is that most past research has been based on recording what is there in the natural fishery. Little has been based on what could be there in a growing operation in terms of oyster size, shape, meat condition, shell condition, or stock density. Therefore, unlike the situation in the rock oyster farming industry, we do not know the quantity of stock a dredge oyster area would support, nor the type of oyster that could be grown. We could well devise highly intensive ongrowing methods for a given area only to find that we had a deterioration in oyster quality or an excessively lengthy growing period.

Ongrowing methods cannot at this time be developed around known biological facts. To some extent they must be experimental and developmental.

Financial possibility

There are several concerns that will affect the choice of ongrowing method. It is extremely expensive in New Zealand to buy material (plant or equipment) that is not readily available. Initial ongrowing methods need to use what is already available. In addition, methods cannot be labour intensive — there is no pool of cheap labour available here as there is in some other oyster growing areas. Nor is there any subsidy or tax concession available to cover the experimental, developmental, or operational phase of any commercial operation.

It is of concern that the latest research paper made available to us proposes that in Canada growing the dredge oyster is profitable only as a cottage farming operation. This is contrary to the experience of the New Zealand rock oyster farming industry. Here it is becoming increasingly difficult for the smaller growers to continue a financially viable growing operation. It is difficult to meet the increasing external costs that have been placed on them to fund water quality testing, the sanitation programme, local and regional authority charges, and the like, in addition to their standard growing costs. Only the larger growers, particularly those with a vertically integrated operation, who have the capital, turnover, cash flow, and shareholders on call, can readily meet these external costs. Again, only the larger operators can meet the costs of the unending upgrading of premises, plant, and equipment.

Unless sufficient area is made available for viably sized operations, and unless an oyster that brings a high price can be grown, then this third basic requirement of financial viability will be very difficult to meet.

Ongrowing options

The main options are whether the oysters are to be ongrown as single separate oysters or as attached oysters requiring separating before sale. There is also the option of the type of starting stock.

Starting stock

There are no methods for ongrowing poor, unfortunate, retarded, misshapen, half-starved spat supplied from a spat grower or a hatchery operator.

Ongrowing requires initial stock that is capable of being ongrown. It is likely that spat from various areas will have different ongrowing characteristics.

I am in some doubt as to where to begin with the ongrowing process. At what stage does spat production finish and ongrowing start? In the rock oyster farming industry, material supplied ranges from spat 1 mm in length to oysters within 6 months of maturity. They come attached and single. In countries using hatcheries to any extent, often only larvae are supplied, and the settlement process is part of the ongrowing activity and is carried out by the grower near the growing area.

If ongrowing begins once the oyster has settled, there are two options — attached or single oyster ongrowing.

Attached oysters

Spat should be received settled at the required density on the pieces of material on which they are to be grown undisturbed to maturity. This material can be made from air-injected PVC with the surface grooved, roughened, or spiked to aid retention. It comes in strips, tubes, or plates. Shells or other similar nonfloating material may be used. Our trials showed that a coating made from equal parts by weight of cement and fresh water, with the addition of Cemkey concentrate, aids settlement and retention.

The spatted material is held in a protected pattern in stacks or bundles until the oysters have reached a size where they can better resist predation. They may be held until the known time of major predation or fouling has passed. The material is then spaced out wider to allow the oysters to reach maturity. The ratio of space from nursery to ongrowing is usually about 1 : 10.

This method of attached growing could be used to produce oysters for the meat trade, the best being selected for a higher level market. The method depends on spat settlement at a required density. If spat settle too heavily, the method would be of use in the intermediate stage of single oyster production, where oysters are grown for a while, then removed from the material they have settled on, separated, and placed in containers to mature.

Single oysters

This method would produce an oyster of better uniform shape. Spat for ongrowing would be received either attached to a strip or plate of material from which they could be readily removed at a smaller size, or as single unattached seed. This method requires material to be reasonably smooth, so that small oysters can be flexed off without damage.

Single oysters are held in various mesh size containers, depending on size. They are thinned out as they grow, and this can be done mechanically. Several thinnings are necessary before spat are put into the container that holds them to maturity. The ratio of space from 6 mm length to final container is usually 1 : 4.

A combination of single and attached options would have single spat fixed to tapes or similar material where they would grow as single oysters.

These single oyster ongrowing methods would produce oysters of better quality, more suitable for a higher priced market.

Ongrowing methods

There are no established commercial methods in New Zealand. Similarly, methods used overseas appear to be in the developmental stage. However, commercial methods used to farm the Pacific oyster appear to be capable of modification to suit the flat oyster.

Intertidal

It is not likely that substantial areas of the intertidal shore would be used for ongrowing; though the lower shore could carry standard racks to be used to harden oysters before sale, to overcome fouling organisms, or to slow down growth, should this be necessary.

On the bottom beyond low water mark

There are four apparent options for bottom culture.

- Single spat could be distributed over the bottom for recovery on maturity. The disadvantages of this method are that oysters would have no protection from predators, possible silting, and loss; they would not be readily recoverable for any remedial action; and the area needed would be substantial.
- Attached spat could be grown in similar fashion with spatted material linked by a common line with a line to a surface float. They would be more readily recoverable than single oysters.
- Single spat could be held in standard Netlon mesh bags on the bottom. These would be joined by a common line with a line to a surface float. Oysters would be protected from predation and would be readily recoverable. If silting occurred, oysters could be moved to another part of the area to allow this to clear after running a chain harrow over the vacant ground.
- Stacks of trays with spacers could be used. This method would allow maximum stocking with single oysters. Silting could be minimised by extending the frame to keep the lowest tray off the bottom. Stacks would carry a float line to the surface. The difficulty would be in devising a method to fix them to the bottom to keep them stable and upright.

Suspended methods

Standard floating longlines could be used to ongrow both attached and single spat to maturity.

Attached growing would use individual pieces of spatted material such as plates or shells spaced out on individual droplines beneath the main line. Material such as strips and tubes (sticks) would be held horizontally as ladders on two joint droplines beneath the main line. The combination method would use single oysters cemented to tapes to be hung from a main floating line.

Single ongrowing could be carried out in stacks of spaced trays. These would require four lines along the sides of the stack to come to a point to join a single dropline which would then split in two to join each side of the mainline. Vertical bags on a single dropline with pockets for individual or a few oysters could also be used. This method, though it ongrows dredge oysters very well, results in a lower yield and is labour intensive.

All suspended ongrowing would need to take place in fairly sheltered waters; otherwise, single oysters would move into heaps, which would slow growth, and attached oysters could be shaken off.

Constraints

The major constraint at present on any ongrowing method is the presence of *Bonamia*. Unless a resistant oyster can be developed, or found, then all that ongrowing methods can offer to avoid it is to raise the oysters off the bottom. This may not be enough to overcome the problem. Oysters ongrown on the bottom would have no more protection than the natural stocks in an area. There may be restrictions placed on the movement of stock between farms and on the supply of spat to farms.

Conclusions

We know that the New Zealand flat oyster is a first grade product. We know that the waters will grow them. Given the past record of farming ingenuity in the country, we can be confident that methods for spat production and ongrowing will be developed.

However, certain matters are outside the potential farmer's control; for example, *Bonamia* and the availability of ground and the tenure that may be offered over it.

I would suggest that further interest is justified, and further developmental work is warranted. To that end, I hope that interested parties, and those here at MAF Fisheries Greta Point, will continue to work together, starting with smaller experimental and developmental field areas, and moving on from there.

Discussion

Hearn said he didn't share the pessimism. He felt the technology developed in the Marlborough Sounds was ahead of the rest of the world: in Chile mussels took longer to grow and Chile had an image problem compared with New Zealand (though they had FDA approval), and Ireland had a mussel industry of 3 000 t annually compared with the 50 000 t in the Marlborough Sounds, which was started at the same time. The techniques are already developed: scallop cultivation techniques would be directly applicable to oysters in the Marlborough Sounds.

There are differences between oysters from various regions and we would want to select for desired characteristics. Dredge oysters need to be separated early, they will drop off sticks easily, and growth is uneven and slower, thus they should be grown as a single oyster, not on a stick. Tapes are used by Japanese for pearl oysters, but they are probably not suitable here because of fouling organisms, particularly sea squirts and tube worms. If they were glued at sufficient size (30–40 mm), they might be able to withstand fouling. Fouling is the greatest problem apart from disease — oysters are static and therefore highly susceptible (scallops will move around in a cage or lantern net and are, therefore, self-cleaning to some extent). If we can sort out growing techniques, I think we'll be successful in the Marlborough Sounds.

Curtin said he was being realistic, not pessimistic. Although there were many people attempting culture of flat oysters, there was as yet no major commercial development. Thus, there was nothing to copy, so New Zealand would have to develop the techniques. There was a need for much more basic research — it was a good product and should be pursued.

Hine said that even in heavily *Bonamia* infested areas (in France, Spain, and the Netherlands) people were still trying to grow flat oysters because of their higher value. The rapid increase in growth of Pacific oysters was partly because of disease problems with dredge oysters, and the feeling was that there would eventually be a market glut of Pacific oysters. If *Bonamia* were detected in a population, one option would be to harvest oysters at a smaller size for sale as a garnish oyster.

Landbased culture of flat oysters has not been attempted, though it has been done with Pacific oysters in Australia (only because release of oysters into the water was not allowed — if it were, a landbased operation would not have been considered).

Hearn said *edulis* was grown in Ireland in an intertidal area which worked by flooding/flushing with the tide (to save pumping costs). This had been successful until TBT, then *Bonamia*, destroyed it. It was noted that there were large grants available for development in Ireland. In Australia there is some fattening onshore after ongrowing at sea.

Fairweather asked what had been done on density with respect to disease susceptibility. He didn't think ongrowing on longlines was the way to develop, but that enhancement of bottom culture at the optimum density was desirable. Hearn commented that there was nutrient deficiency on the bottom, but not higher in the water column. Smith said that there was a theory that moving up from the bottom would reduce the input of *Bonamia* spores. He also said that in France *Bonamia* wasn't a problem at low density, but these densities were too low for farming to be economical in New Zealand. Hearn commented that he had had high densities of dredge oysters in his mussel farm and they were in very good condition — they seemed to be able to extract nutrients more efficiently than mussels and withstand fouling better. He also said there was no correlation between condition and the incidence of disease; you can have high condition factors in oysters with high *Bonamia* infection levels.

Licensing requirements

D. Hooper

MAF Fisheries Greta Point

Background

Over the last 20 years or so marine farm activity has been controlled and licensed under the Marine Farming Act 1971 (MFA). However, the introduction of the Resource Management Act 1991 (RMA) significantly changed the way marine farms were licensed. New marine farmers are now required to obtain a resource consent from regional councils under the RMA rather than a lease or licence under the MFA.

The first draft of the RMA was introduced by the Labour Government on 7 December 1989 in an attempt to simplify and rationalise the legal structures governing natural and physical resource management in New Zealand. The aim was to create a more efficient, consistent, equitable, and flexible structure for the protection of the environment and the sustainable use of resources. The National Government continued the development of the Bill, which was finally enacted on 22 July 1991 and came into effect on 1 October 1991.

The RMA replaced almost all environmental and resource use laws in New Zealand, and it incorporated land use and subdivision, water and soil, air and noise pollution, and other resource use laws. The RMA is administered by the Ministry for the Environment. Various functions, powers, and duties are assigned to central and local authorities and the Minister of Conservation.

As part of the above purpose the RMA established a new coastal management regime. This regime replaced a range of existing consent procedures in the marine area, including those in the MFA, the Harbours Act 1950, and the maritime planning provisions of the Town and Country Planning Act 1977. The coastal management provisions of the RMA are administered by the Department of Conservation via regional councils.

Subject to environmental limits, councils will allow the controlled use of space and resources through the allocation of resource consents, e.g., a coastal permit is required for the coastal environment. There are several different classifications for activities which are available to councils. The type of classification dictates the level of control over the issuing of resource consents for certain activities in their area, e.g., dredge oyster farming may be a controlled activity, restricted coastal activity, or even a prohibited activity, depending on the particular region.

Current situation

New marine farmers need to apply to regional councils for a resource consent (coastal permit) issued under the RMA. However, section 418(6) of the RMA states that holders of current leases and licences issued under the MFA have an "existing use" right which continues until the expiry of the term of the lease or licence. Section 426(1) provides that existing leases and licences will also continue under the same terms and conditions until the lease or licence expires. Section 426(1) also states that all of the provisions of the MFA will continue to apply to any lease or licence issued before 1 October or issued subject to section 397(1), even though the relevant sections have been repealed. In addition, several provisions of the MFA remain in force to allow MAF Fisheries to continue its management role in relation to fisheries (*see* below).

Applications for licences under the MFA, received and advertised before 7 May 1991, are being processed and will be managed under the MFA by MAF Fisheries. Thus, marine farms are currently allocated and managed under two different legislative regimes.

Section 13 of the MFA allows the parties to a lease or licence to vary any of the conditions, covenants, or agreements of the lease or licence. Variations can be, for example, a change in species or an increase in the term of the lease or licence. Even though this particular section of the MFA has been repealed, the above provisions of the RMA mean existing lease or licence holders can continue to obtain variations to their leases and licences. Thus, there is a dual licensing system for marine farms. The process you follow depends on whether you hold an existing lease or licence under the MFA.

Process for holders of leases or licences under the MFA

Farmers who hold an existing lease or licence under the MFA, and want to farm dredge oysters on their existing property, can apply to MAF Fisheries for a variation of species on their current lease or licence.

The process for an application to include another species on an existing lease or licence is:

1. application sent to MAF Fisheries;
2. MAF Fisheries acknowledge receipt and pass to scientist to clarify whether variation requires advertising;
3. if no advertising is required, move to step 9;

4. if advertising is required, advertising details sent to applicant;
5. application advertised by applicant in local papers;
6. 2 month objection period allowed;
7. 1 month period to allow submissions in reply to objections;
8. MAF Fisheries to examine application pursuant to section 7 of the MFA (looking at objections);
9. MAF Fisheries to prepare submission for Minister's decision under section 13 of the MFA;
10. on receipt of Minister's decision, MAF Fisheries prepare Memorandum of Variation documents or advise applicant of Minister's decision to decline application;
11. Memorandum of Variation documents sent to applicant for signature;
12. MAF Fisheries prepares submission to Minister requesting final execution of Memorandum of Variation;
13. on receipt from Minister of executed memorandum documents, MAF Fisheries to distribute memorandum and other relevant documents to interested persons;
14. variation of licence issued.

Although any individual variation needs to be examined on merit, the smaller the change in current practice the more likely it is that there will be no requirement to advertise, i.e., an application from a mussel farmer wishing to farm dredge oysters by using similar structures, such as longlines, would probably not need to be advertised. This should help to significantly speed up the application process.

A further problem could arise if the lease or licence of the prospective dredge oyster farmer was due to expire in the near future. In this instance, an extension of term would also need to be obtained.

The process for an extension of term of an existing lease or licence is:

1. application sent to MAF Fisheries;
2. MAF Fisheries to undertake site assessment;
3. applicant required to fulfil obligations under conditions of licence;
4. notification by MAF Fisheries pursuant to section 13(5) of the MFA;
5. 2 months provided for comments on notification;
6. consultation with marine farmer over amendment of licence conditions;
7. MAF Fisheries to prepare submission and letters requesting Ministry of Transport and Department of Conservation concurrence for Minister's signature;
8. MAF Fisheries to prepare new licence documents and forward to licensee for signing and/or forward licensee's issued copy of original document and office copy to MAF Fisheries head office for noting of cover sheet and entering in register of marine farming licences;
9. MAF Fisheries to prepare submission to Minister requesting final execution of licence documents;
10. on receipt of executed documents from the Minister, MAF Fisheries to distribute licence documents and other relevant documents to interested persons;
11. provided all criteria are met, extension of term registered.

N.B. In addition to the normal conditions of a licence, a Memorandum of Variation for dredge oysters will also include conditions covering source and transfer restrictions for disease reasons.

Process for new marine farmers

Applicants who do not currently hold MFA leases or licences will need to go through the resource consent procedures. This will mean applying to the appropriate regional council for a coastal permit. Depending on the amount of processing being considered there may also be a requirement to obtain other resource consents, i.e., a land use consent from the district or city council. The term for any resource consent is discretionary up to a maximum of 35 years.

A rough guide taken mainly from "Applying for a Resource Consent", an information sheet provided by the Ministry for the Environment, is given below. However, the resource consent process will depend on the area being farmed and the particular regional plan in force. The best way of obtaining a better understanding of what is going to be required for your specific area is to talk to your own regional council representatives. However, the following overview is a guide. The basic information requirements for all resource consents are outlined in section 88 of the RMA. This states that the application shall include:

- a description of the activity for which the application is sought;
- an assessment of the effects the activity may have on the environment and the ways that adverse effects may be mitigated, in such detail as corresponds with the scale and significance of the effects on the environment;
- any information required by the plan or regulations;
- a statement specifying any other resource consents which may be required with respect to the activity and whether the applicant has applied for these.

The consent authority can ask for more information, but only if the information is necessary to enable the consent authority to better understand the nature of the activity, the effect it will have on the environment, or the ways in which the adverse effects may be mitigated.

If the coastal permit includes discharge, the applicant can be asked for details about the nature of the discharge, the sensitivity of the receiving environment, and the applicant's reasons for making the proposed choice. Information on alternative methods of discharge, including discharge into any other receiving environment, can also be sought.

The consent authority can also commission a report on any matters raised by the application, including a review of any information provided on environmental effects.

Depending on the nature of the information requested and the speed at which the applicant can provide it, the consent authority has the power under section 92(3)(a) of the RMA to postpone the public notification or the hearing on the application. The new information has to be made available to the public 15 working days before the hearing. Any report commissioned must be sent to the applicant 15 working days before the hearing. Although the time restrictions specified can be extended, if reasons are stated and affected persons notified, no extension can more than double the maximum period specified by the RMA.

Whether a resource consent has to be notified will depend on what the regional plan says about marine farm activity. The general rule is that controlled activities need not be notified, although written approval of every person adversely affected may be required. The consent authority can waive this requirement if circumstances make it unreasonable.

Resource consents for discretionary or non-complying activities may also be non-notifiable. This would occur only if the consent authority were satisfied that adverse effects on the environment would be minor and that written approval had been obtained from all people likely to be adversely affected. However, most consents will be notified, and marine farming activity, including that of dredge oysters, is likely to fall within this category. It is also important to note that a council can decide that an application should be publicly notified, even if the plan expressly provides that such an application need not be notified.

When there is a requirement for public notification, the consent authority must do so within 10 working days of receipt of the application. When further information is required, the application must be notified within 10 working days of receipt of this information. In addition to a public notice in the newspaper, a notice is also attached to the property concerned advising of the resource consent application and the public right of comment.

Any person can make a submission to support or oppose a resource consent application that is publicly notified. They have 20 working days from the date of notification. The person making the submission must also give the applicant a copy of that submission, and the consent authority must provide the applicant with a list of submissions as soon as practicable after submissions have closed. The submission must state whether the person wishes to be heard in support of that submission.

A hearing will be held if the consent authority considers it necessary, if the applicant requests one, or if any person making a submission has asked to be heard.

Pre-hearing meetings can be held to try to clarify, mediate, or facilitate a resolution of any matters. These pre-hearing meetings have no effect on the time limits imposed by the RMA.

Any hearing must begin no later than 25 working days from the closing date of submissions, and at least 10 working days notice of the time and place must be provided.

A joint hearing could be called to allow two separate consent authorities to look at several resource consent applications for the same proposal. The consent authorities may make a joint decision (unless one of the consents is for a restricted coastal activity), but separate resource consents will be provided.

If dredge oyster farming is a restricted coastal activity under the local regional plan, the application will be heard by a committee of the regional council which will include a person appointed by the Minister of Conservation. The committee will make recommendations to the Minister of Conservation, who will make a final decision on the application.

The applicant, or any person who made a submission on the application, can appeal any decision, provided the appeal is lodged with the Planning Tribunal and served on the consent authority within 15 working days of notice of the decision.

The decision of the Planning Tribunal is final, unless appealed on a question of law.

Control of resource consent marine farms

The introduction of the RMA still leaves MAF Fisheries with responsibilities in relation to controlling activities and species management on marine farms. The RMA only authorises occupation of a marine site and is designed to manage adverse environmental effects. MAF Fisheries retains the fisheries management role.

There is a need to examine what regulations are introduced, to ensure that activity relating to species management on marine farms administered by resource consents is properly controlled once approval is obtained from regional councils. Currently, most controls on marine farming activities are included in the lease or licence issued under the MFA.

As well as retaining MAF Fisheries' current role for existing leases and licences, the RMA has inserted section 42B into the MFA; thus, the following will apply to any coastal permit issued under the RMA for marine farming:

- sections 32(a), 33, 36, 37, and 38 (which are offence provisions);
- section 41 (which provides powers of inspection of marine farms);
- section 42 (which provides for closing orders where disease is found);
- sections 48(1)(c–k) and 48(2) (which provide for the making of regulations to control certain marine farming activities).

This means that MAF Fisheries administers the above provisions of the MFA on the holders of coastal permits issued by regional councils.

Therefore, marine farms established through the resource consent process will be subject to regulatory controls established under section 48 of the MFA. MAF Fisheries staff are working to ensure that any controls are kept to a minimum and unnecessary restrictions on marine farm activity are avoided. It is not the intention of MAF Fisheries to place unnecessary or Draconian controls on aquaculture farmers. Wherever possible, MAF Fisheries is trying to ensure measures have the smallest impact possible. In most instances, regulations will only reinforce current sound aquacultural practice and what is currently on existing leases or licences under the MFA; however, it is important that MAF Fisheries ensures that, with the potentially broader scope of species being farmed, wild fisheries are protected. A full consultative process will be undertaken once an initial paper outlining regulatory suggestions has been completed.

Discussion

In the course of the discussion Hooper outlined intended changes in the licensing procedure.

One issue that was raised was the possible requirement for marine farmers coming in under the resource consent procedure in the Resource Management Act 1991 also requiring approval from MAF Fisheries under the Fisheries Act 1983.

Section 49 of the Marine Farming Act 1971, which ensured that all marine farms licensed under the Marine Farming Act 1971 were exempt from the Fisheries Act 1983, does not apply to those marine farms coming in under the resource consent procedure. These farms are, therefore, technically required to comply with all aspects of the Fisheries Act 1983 in regards to the taking, possession, acquisition, disposal, or disturbance of fish or marine vegetation.

However, this issue is currently being worked through with the Minister of Fisheries and MAF Fisheries, and no final decision has yet been made as to what this requirement will mean for marine farmers at a practical level. Marine farmers will be informed as soon as the final decision is made.

Hine stated that MAF Fisheries proposed that the transfer of species be regulated by the division of New Zealand into regions: movement within regions would be allowed, but movement between would require MAF permission. The Animals Act 1967 will be superseded when the Biosecurity Bill becomes law, but the intention is to keep the current system to protect farms within a region. The system is not meant to be intrusive. The transfer restriction applies only to flat oysters, because of the threat of *Bonamia*; there are no controls on, for example, kina or Pacific oysters, and none are intended because of the lack of a serious disease. There is a necessity to maintain New Zealand's international credibility with regard to hygiene.

[For the purpose of controlling transfer of Bluff oysters within New Zealand, MAF Fisheries has proposed that movement of oysters between any of the following areas will be restricted: Tirau Point to Cape Runaway, Cape Runaway to Cape Palliser, Cape Terawhiti to Tirau Point, Cape Koamaru to Clarence Point, Cape Stephens to Cape Koamaru, Cape Farewell to Cape Stephens, Awarua Point to Cape Farewell, Clarence Point to Waimakariri River, Waimakariri River to Nugget Point, Chatham Islands. Movement of oysters into any of the following areas will not be restricted: Cape Palliser to Cape Terawhiti, Nugget Point to Awarua Point.]

Department of Conservation perspective

J. Hare

Department of Conservation, Invercargill

I speak as a coastal planner with the Department of Conservation, with 5 years' experience in marine farming consents and planning, on both sides of Foveaux Strait. My primary involvement has been with the farms in Big Glory Bay on Stewart Island; however, I am also aware of the problems of the Bluff oyster fishery and the consequent interest in farming oysters in the south. Over the past 2 years both my conservancy and the Southland Regional Council have received a steady trickle of inquiries about oyster farming.

I will briefly describe the interests of the Department of Conservation (DoC) with respect to marine farming, and then talk about the specific effects of dredge oyster farming most likely to be of concern to the department. I will also summarise our interests because the marine farm approval system is at a complex stage and there are two parallel consent systems.

I have focused on the South Island because I understand that dredge oyster farming is unlikely to occur north of Tasman Bay, for biological reasons. In particular, when discussing areas available for oyster farming, I have focused on the Southland region and on the Marlborough Sounds, the two areas in which most forward planning of suitable sites for marine farming has been undertaken by the consent agencies. Although I am aware of a special permit to farm oysters in Canterbury, I am not aware of any marine farm planning yet undertaken by the Canterbury Regional Council.

The department's role in marine farming comes from two Acts, neither of which is the Conservation Act, with which we are commonly associated. Our role comes from the Marine Farming Act (MFA) and the Resource Management Act (RMA). I intend to focus not only on conservation perspectives about dredge oyster farming, but also on a wider environmental perspective, derived from the legislative constraints of these two Acts.

In New Zealand, marine farming proposals are currently dealt with on an application by application basis, guided by legislation and in some instances by departmental policy.

Existing licence holders are dealt with under the MFA, and they may apply for a variation to their licence to allow farming of oysters. In most instances these will be variations to existing shellfish farm licences, such as for mussel farms. If this is so, farming oysters as well is not likely to result in any significant increase in adverse effects on the environment, except with the problem of *Bonamia* introduction to new areas. The Minister of Conservation is not required to concur with these variations. Thus, overall, it is unlikely that DoC would have any significant interest in these variations. However, we do have an interest in any structures which may be used for farming oysters on these existing licence sites, because there are some residual functions for the approval of these that we have retained under the Harbours Act. I will not dwell on these, because I intend to focus on the RMA.

New applications for marine farming come under the RMA. Under this Act DoC represents the Minister of Conservation, who has a partnership with regional councils or unitary councils in coastal management. The RMA is to control effects on the environment and to ensure sustainability, and DoC concerns are one aspect of this — the Act provides for allocation of space in the coastal marine area through the issue of a coastal permit or through regional coastal plan provisions.

I cannot speak for individual regional or unitary councils, who are responsible for day to day consent application processing. The department's role is primarily to set policy. However, in areas of significant conservation value we maintain a more specific interest — if activities in such areas are likely to have a significant adverse or irreversible effect on the environment, the Minister of Conservation is the ultimate decision making authority, although councils still manage the consent process. These areas have yet to be identified, some may be small, some large. As an example, all of the coast adjacent to Fiordland National Park is likely to be recognised as an area of significant conservation value. Until the New Zealand Coastal Policy Statement is gazetted, the Minister of Conservation has issued directions about when he will decide consents. The only transitional direction likely to affect oyster farmers is if a proposed farm would exclude public access to areas over 10 ha or would restrict it on areas over 50 ha. The New Zealand Coastal Policy Statement provisions will supersede these transitional directions. It is envisaged that the draft policy will be notified in late July or early August.

Whether an application is assessed under either of these two different Acts (MFA or RMA), the primary environmental issues or concerns are likely to be the same. However, the way in which they are weighed up, and the resultant outcome, may differ because of the different emphasis in legislation.

With the RMA has come belated recognition of the importance of the environment, that we are dependent on its healthy state. This is, of course, not a new idea for marine farmers. The RMA requires that an assessment of the environmental effect of each proposal be undertaken, on a site by site basis, and that this be submitted with the application. The idea of assessing the likely impacts of a proposed development on the environment is not new either. The RMA has formalised procedures that have been around in New Zealand for 20 years. Under the new legislation, applicants have to spend more time obtaining and supplying adequate information, but this can be compensated for by a quicker hearing procedure. Relevant likely effects need to be considered in each instance; the range, magnitude, and significance of each should be identified.

Because dredge oyster farming has not been tried on a commercial scale yet, the specific environmental effects have not been studied. However, it is possible to generalise both from our experience with mussel farms and with Pacific oyster culture here and overseas. The types of effects which are relevant will depend on the method of farming proposed, the technology to be used, and where the farm is to be sited. Many impacts are likely to be much the same as for other shellfish farming, except for the disease factor (because of *Bonamia*). Many will be specific to the proposed site.

Concerns that would be general to all types of oyster farming methods would include the impact on the landscape, the sea bed, other users of the area, and navigation, and also cultural concerns including taking account of the Treaty of Waitangi and the special relationship of Maori with their ancestral lands, water, sites, waahi tapu, and other taonga.

New farms are more easily absorbed into the landscape when there is already a high degree of visual modification, such as existing farms. In the Marlborough Sounds new marine farms would generally not be supported by DoC if they would affect significant stretches of coastline which have been kept largely free from on-water development, for example, in Queen Charlotte Sound (Department of Conservation 1990). In the Southland region, farming would be discouraged in Fiordland and in remote areas of Stewart Island, including Port Pegasus, for this reason (amongst others). There is likely to be more support from DoC for marine farms on the southern South Island coast, west to Te Waewae Bay, because this area is already more extensively used and modified than remote coasts in the region, many of which are adjacent to protected land.

Marine farms can increase the risk of rodents infesting predator free islands, because the structures can provide "stepping stones". Increased levels of human activity can also be a problem in some areas used by wildlife; for example, locating farms near areas where yellow-eyed penguins come ashore regularly, or in which shags nest, would be discouraged if it were thought likely that the farming would adversely affect the wildlife. For this reason DoC's marine farm policy includes provision to protect areas with significant wildlife values from marine farming effects.

There are several matters of national importance identified in the RMA. These include the preservation of the natural character of the coastal environment and its protection from inappropriate subdivision, use, and development. They also include the protection of outstanding natural features and landscapes, significant habitats of indigenous fauna, and areas of significant indigenous vegetation. Regional coastal plans should identify sites which meet these criteria in each region. These are all matters that must be considered when an application is submitted.

I am going to assume that dredge oyster farming could potentially be undertaken in the intertidal zone, on the sea floor, or in hanging cultures in the water column.

Experience with intertidal Pacific oyster farms has shown that they require large areas. This effectively excludes other "users", including wading birds which feed on these flats. Estuaries are productive areas which nourish coastal fisheries; they act as buffers between land and sea and are often popular recreation sites and areas from which to gather kaimoana. It is important to protect their ability to function in these roles and to ensure that essential processes are not disturbed to such an extent that the estuary life cannot sustain itself.

Intertidal racks can adversely affect local hydrodynamics and sedimentation patterns if sited unwisely. Fine sediment fractions are incorporated into the natural sediments because oysters are filter feeders, so they accumulate fine sediments in their faecal deposits, and farm structures cause sediments to drop out of the water. This may be seen as softer and more fluffed sediment around the racks. If the sediment buildup were excessive and affected sedimentation in other areas, by causing erosion there for instance, concern might be sufficient to make the site unsuitable for oyster racks.

Many of our estuaries are already greatly modified by human impact. If intact vegetation sequences, from wetland or coastal forest out on to the flats, for example, still exist, they should be protected.

In the Marlborough Sounds the areas that would be suitable for intertidal culture are small and extremely vulnerable ecologically. Most of the intertidal zone is narrow. Only one or two areas in the inner Pelorus Sound or Squally Cove in Croisilles Harbour could be set aside for intertidal oyster culture (Department of Conservation 1990). In Southland estuaries there are probably areas available for oyster farming, but unless a comprehensive planning study is undertaken, as may be done during the preparation of the regional coastal plan, these areas can only be ascertained on a site by site basis at the time of application. However, a Southland United Council study in 1989 identified many of the relevant considerations and offered guidance on suitable areas (Southland United Council 1989).

Oysters filter suspended material, mainly plankton, from the water. In hanging cultures, they are farmed at far higher densities than in their natural habitat, without any artificial supply of nutrients. Consequently, there is a potential effect on other filter feeders in the area — sponges and ascidians, for example. It has been suggested that there may already be a shortage of plankton at some times of the year in Beatrix Bay in the Marlborough Sounds.

Under hanging cultures there is likely to be some organic pollution of the sea bed. This may not be a problem if farming is on a small scale. Our experience with mussel and salmon farms has shown that the effect of the buildup of waste sediments is determined by factors such as current speed, water depth, and the nature of the sea bed. If shellfish farms were allowed, we could accept that the sea floor life under the farm would be modified, and possibly smothered. In some instances it would be wise to avoid this; for example, in the Stewart Island inlets, beds of red seaweeds growing on the muddy sea floor are common at depths of 7–20 m. These beds have a role in stabilising finer sediment fractions and maintaining the low level of suspended sediment and high water clarity in these inlets. However, there are alternative, deeper sites for mariculture.

For reseeding programmes, if they were part of subsequent harvesting, and exclusive harvesting rights were being sought for an area which would mean excluding current recreational and Maori fishing interests for reasons of private gain, DoC would generally not be supportive.

Dredging and bottom trawling are major modifiers of the sea bed in New Zealand. The department would encourage further dredging to occur in areas already subject to such disturbance rather than in unmodified areas, which are often important stable habitats. Similarly, for Stewart Island inlets, dredging areas with red seaweed beds or brachiopods would not be viewed favourably.

Oyster farms need to make provision for the disposal of dead shell, including mortalities from disease outbreaks. It is not necessarily desirable to dump these at the most convenient spot in the sea. A dumping site where the environmental impacts will be minimal needs to be designated.

The department's concerns about the introduction of new species to an area in which they do not occur naturally relate to their effect on natural communities. This may be compounded when genetically modified native species are used if there is any possibility of the native gene stock in the area being lost. Regional policy statements and plans should address this issue of acceptable or unacceptable introduction of species and gene modification, to give some certainty to farmers.

Scale is important when assessing the likely impact of a farming proposal. There is a requirement to consider cumulative effects, both the additional effect of adding an oyster farm to an area used for other purposes, and the effect of the oyster farm on other users (except the effects of trade competition, which are not a consideration under the RMA). Single proposal issues may be simple; cumulative ones very complex.

Many of the concerns about oyster farms relate to large scale operations. As with other shellfish culture, the introduction of seeded oysters, their rearing, and their harvest will disrupt the natural cycling of material through the ecosystem. Large harvests result in the artificial removal of nutrients from the coastal ecosystem. Dense oyster cultivation may facilitate the introduction and propagation of strains of bacteria or parasites not present before. The spread of infectious diseases is primarily an industry concern, but may affect a natural ecosystem, particularly one that is already stressed, for example, the Foveaux Strait oyster beds.

Overexploitation leads to food depletion and makes the sediments below the farms rich in organic matter. Pacific oysters produce large deposits of faecal discharges. Sediments beneath these farms are rich in total nitrogen, total sulphide, and free hydrogen sulphide. The latter is potentially toxic to aquatic life. In Japan, when hanging culture of *Crassostrea* was repeated in the same area of shallow water for some years, production gradually declined. This was mainly attributed to physical and chemical changes in the polluted bottom sediments. This is obviously more serious where organic discharges already exist, and it can be assumed to lead to environmental changes in the ecosystem. Dense cultivation can also markedly accelerate eutrophication.

When intensive farming is proposed, development must be planned to ensure environmental sustainability, including estimating the carrying capacity of an area. In the absence of good information about the likely effects of a certain scale of farming, a precautionary approach should be adopted; for example, restricting the density of rafts in an area, so that sediments do not deteriorate as a result of faecal accumulation.

Part of the concept of sustainability is avoiding adverse effects where possible, remedying them if they can't be avoided, and if that is not possible, at least mitigating them. The emphasis is on avoidance. It would be wise to identify potentially adverse effects as early as possible, so that the operation can be designed to avoid them. The emphasis is on early consultation with the consent agency and interested parties, before submitting an application. Once the application is submitted and the council accepts that sufficient information has been provided to allow a decision to be reached, the clock starts ticking and the tight timeframe in which applications have to be considered has begun. You don't want your application turned down and then have to start again with an alternative proposal, if the problem could have been sorted out at an early stage.

There are various ways of avoiding or mitigating adverse effects. Many of the problems are likely to be siting issues. Each site must be inspected before application, including the sea floor. The unexpected may be revealed, for example, sponge gardens have been found in the heads of some bays in the Marlborough Sounds, and black coral has been found in an unusual habitat at Port Pegasus on

Stewart Island. However, alternative sites may be available nearby.

Potential landscape disruption may be minimised quite simply, for example, by using nonglare or appropriately painted surfaces on sheds to blend in with the background. These are issues that should be dealt with as part of the application process, not in an ad hoc manner afterwards.

Another essential part of forward planning which should be dealt with at the time of application is deciding how to dispose of the farm, should it no longer be needed for any reason. Rehabilitation planning, about how to restore an area to its previous state, is needed. My experience with marine farming structures, including an old oyster farm, is that, once no longer required, they are often abandoned on site or on a nearby beach and become an eyesore and a hazard.

In future the need to deal with all marine farming proposals on an application by application basis may change as regional coastal plans are developed by regional and unitary councils. For example, certain types of farms, that is, farms with certain effects on the environment, may be permitted in an area provided they meet the requirements set out in the regional coastal plan. In this instance, a resource consent would not be needed, merely a (simpler) certificate of compliance.

Regional coastal plans can potentially recognise opportunities for aquaculture. They could provide for dredge oyster farming in certain areas where cumulative effects could be controlled, by a limit on raft density, for example, provided a monitoring programme was installed to give an early warning system for significant effects. Monitoring should not be treated as something to be tacked on afterwards if the consent authority makes a fuss about it — it is one of the requirements for preparing environmental impact assessments, set out in the fourth schedule of the RMA. When effects on the environment are significant, a monitoring programme should be submitted with the application. A programme would also be needed if cumulative effects of several farms were likely to be significant and if farmers wish to make efficient use of an area. Developing a programme for an area where many farms are sited would require cooperation among those users to efficiently share their expertise and to negate unnecessary duplication. This exercise is currently being undertaken in Southland for the Big Glory Bay salmon farms, as a joint approach between various agencies and the industry.

I have not been able to find much information on the likely specific effects of dredge oyster farming, but I hope this workshop will bring more to light. In the meantime, we should take a cautious approach and gather information on environmental impacts along the way.

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Discussion

Curtin commented that if siltation were a problem, dragging a chain over the bottom could break it up. Hare noted that siltation may be acceptable in some areas, but not others. Barker noted that there was a large flat oyster industry in the top of the South Island in the late 19th Century, so there should be no restriction on putting flat oysters back into the area. Hare replied that DoC didn't have any objection to this. With any new development they wished to limit harmful effects, so they required good documentation preparation and close monitoring to aid in identifying any potential problems, rather than preventing development per se.

Public health standards

P. Busby

Shellfish Regulatory Authority, MAF, Wellington

1. Background

1.1 Dredge oysters are a species of shellfish which fall into the group called molluscan bivalves. This group receives special attention on an international scale in food safety law because:

- Molluscan bivalves are filter feeding shellfish — in their aquatic environment they can filter and accumulate to hazardous level: pathogenic microorganisms, viruses, protozoa, helminths, marine biotoxins, or toxic substances such as heavy metals, and they can become naturally contaminated with autochthonous microorganisms such as *Vibrio* spp.
- No thermal process to eliminate pathogens is generally applied to oysters before sale.
- Microbial multiplication is likely to occur if time and/or temperature abuse occurs between harvest and sale; for example, a recent study showed a 10 to 100 times increase of *Vibrio vulnificus* between harvesting and processing, and greater increases in *Vibrio parahaemolyticus*.
- Raw molluscan shellfish receive the second highest hazard rating for all foods (International Commission on Microbiological Specifications for Food (ICMSF) and the National Advisory Committee on Microbiological Criteria for Foods, HACCP Report).
- There is epidemiological evidence to support the commonly used limits for (faecal) coliform densities of shellfish gathering waters.
- More studies are showing the presence of pathogens in waters and shellfish when (faecal) coliforms are either absent or in low numbers. Foremost among these studies are those conducted in New Zealand on viral contamination of wastewaters, sediments, and shellfish. These findings reflect the greater die-off of coliforms relative to pathogens under certain circumstances and are of concern because they suggest that disease risk may sometimes be underestimated by (faecal) coliform densities.

1.2 In 1980, at the request of the shellfish industry, a Memorandum of Understanding was signed between the U.S. Food and Drug Administration (FDA) and the N.Z. Ministry of Agriculture and Fisheries. The memorandum affirmed the intention of MAF to assure molluscan bivalves exported to the U.S. were safe, wholesome, and had been harvested, transported, processed, and labelled in accordance with the U.S. FDA National Shellfish Sanitation Programme (NSSP). (The NSSP assumes that a relationship exists between pollution from human or animal activities, shellfish growing waters, and human illness. Pathogens or other pollutants may enter growing waters through direct discharges of wastes or through non-point runoff from streets, farms, or bush. Oysters may filter out and concentrate the pollutants or pathogens.)

1.3 The 1980 memorandum also contained a Memorandum of Understanding between MAF and the Department of Health (DoH). This placed the responsibilities for the sanitary survey, classification, and monitoring of shellfish growing areas with the DoH. The MAF-DoH memorandum is still in effect, but the above work is performed by area health board health protection officers.

1.4 As a result of the 1980 memorandum, all shellfish growing areas which provided shellfish for export, and most of the shellfish growing areas which provided shellfish for sale in New Zealand, underwent a sanitary survey and were classified under the NSSP. Although it was mandatory for all export shellfish to be harvested from classified growing areas, it was not mandatory for shellfish for sale in New Zealand. This caused concern to the shellfish industry, MAF, and DoH, and in 1988 the shellfish industry formally requested through the Shellfish Sanitation Committee that the N.Z. Food Regulations 1984 be amended to require this and also that a New Zealand standard be designed to apply to all commercial shellfish grown and harvested in New Zealand, irrespective of whether destined for the New Zealand or export market.

1.5 In December 1991, Amendment No. 5 of the N.Z. Food Regulations 1984 was passed. This requires that shellfish grown and harvested for the domestic market meet the requirements of the NSSP. The amendment becomes effective on 1 January 1993.

1.6 In February 1992, the Fishing Industry Inspection and Certification Council (which is responsible for fish export standards) approved Industry Agreed Standard (IAS) 005: Shellfish Quality Assurance, as recommended by the Fishing Industry Board Shellfish Sanitation Advisory Committee, and it is being prepared for publication. The IAS is based on the NSSP requirements, but adapted for New Zealand growing water conditions.

1.7 The Third Schedule of the Resource Management Act 1991 provides a further standard designed specifically for shellfish growing water quality, and it is expected that all IAS 005 classified growing areas will be classified under the above Act as Class SG.

2. Assurance of shellfish safety

There are three internationally accepted and practised systems for assuring the safety of shellfish. Each of these is provided for in the NSSP and the IAS 005, and each is practised in New Zealand in accordance with the above two standards. The three systems are briefly described below. Although growing water classification is an acceptable system on its own, it is also a prerequisite to relaying and depuration.

2.1 Growing water classification

For shellfish to be harvested for direct marketing, not only must the growing waters be of high quality, but also there must be limited potential for water pollution. For example, in New Zealand most of the 55 classified growing areas are closed for various periods (up to 7 days) after various levels of rainfall (e.g., 25 mm in 24 h) as the growing water has been shown to be affected by land runoff. Another example is the closure of some growing areas over Christmas and vacation periods because of the potential impact of boats.

Poor water quality can mean contamination with faecal matter or chemical pollution. Both can be the cause of a growing area closure, but, in practice, most closures are due to faecal contamination.

To determine the actual and potential sources of pollution that may affect a growing area, a sanitary survey is conducted by a health protection officer. The sanitary survey is the most critical factor in providing assurance of shellfish safety. The factors involved in conducting a sanitary survey are described in Appendices 1 and 2.

Each growing area is required to be surveyed at least once every 12 years. Annual requirements include specified water sampling, pollution source evaluation, and an annual growing area report.

All shellfish growing areas where shellfish are taken for domestic or export sale are required to be awarded one of the following classifications based on the information in the sanitary survey report:

approved	—	direct harvesting for sale allowed
remote approved	—	direct harvesting for sale allowed
conditionally approved	—	direct harvesting under certain conditions
restricted	—	direct harvest not allowed — relay or depurate
conditionally restricted	—	relay or depurate only, with certain conditions
prohibited	—	no harvesting permitted.

In general, the classification awarded is based on the faecal coliform levels in the growing water. The mean faecal coliform count of approved waters must be no higher than 14 MPN per 100 ml of water. (MPN, Most Probable Number, is a statistical estimate of the number of faecal coliforms in the water determined from the results of laboratory incubations.) The higher the faecal coliform count, the greater the likelihood that disease causing organisms also are present. For this reason, shellfish taken from areas where the mean faecal coliform count does not exceed 88 MPN per 100 ml must undergo cleansing, either through relaying in "approved" waters or through depuration. Both cleansing procedures have specified procedures (e.g., in the NSSP and IAS 005 manuals) which must be followed.

2.2 Relaying

Relaying is a cleansing option for moderately contaminated oysters, i.e., those which have been harvested from growing areas in which the mean faecal coliform count does not exceed 88 MPN per 100 ml.

Cleansing occurs by natural biological purification and allows the reduction of contaminant microorganisms to safe levels. The length of time required for the cleansing process is influenced by many factors, but is generally less than 14 days.

Specific procedures to be followed for relay operations are described in detail in IAS 005 and the NSSP manuals.

2.3 Depuration

Depuration is another cleansing option for oysters taken from growing waters in which the mean faecal coliform count does not exceed 88 MPN per 100 ml.

This controlled purification method of cleansing is a complex biological process requiring specific control measures for the plant operators. These are described in detail in the NSSP manual and the IAS 005. Although depuration generally takes only 36–48 h to cleanse oysters, it may not adequately remove viruses and some pathogens.

3. Cost recovery

To achieve the Government requirement for full cost recovery, shellfish delivery centres have been formed in all shellfish growing areas. The MAF Quality Management circuit inspector is the centre coordinator and other members of the centre are an area health board health protection officer and representatives of marine farmers and processers.

There are currently seven delivery centres — Northland, Auckland, Coromandel, Nelson, Marlborough Sounds, Dunedin, and Invercargill. An example of the structure, functions, and personnel involved in a delivery centre is shown in Appendix 3.

In brief, the costs for a particular growing area are divided among the marine farmers on a per hectare or per licence or lease basis — the costs and methods of charging vary greatly from one centre to another, but, as an example, the annual cost per hectare for mussel farmers in the Marlborough Sounds is about $100.

4. Summary

To meet public health requirements, each oyster farming area is required to undergo a sanitary survey and classification. This work is performed through regional or local shellfish delivery centres by area health board health protection officers on a full cost recovery basis.

5. References

McBride, G. B., Cooper, A. B., & Till, D. G. 1991: Microbiological water quality guidelines for recreation and shellfish gathering waters in New Zealand. DSIR Water Quality Centre Consultancy Report 6211.

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Provisional microbiological water quality guidelines for recreational and shellfish-gathering waters in New Zealand. Public Health Services, Department of Health, January 1992.

United States Department of Health and Human Services, National Shellfish Sanitation Programme manual of operations, parts I and II, 1990 revision.

World Health Organisation guide to shellfish hygiene. WHO Offset Publication No. 31, 1976.

Appendix 1: Model sanitary survey report

The following outline of a model sanitary survey report has been included to illustrate the wide variety of factors that may be encountered during the planning, execution, and documentation of a complex growing area sanitary survey. It is expected that each report will be organised in a similar format to that shown in this model and that all applicable factors listed in the outline will be considered in planning, conducting, and writing the report. The model is also useful as a checklist to determine what survey information should be collected, to promote national uniformity in survey report preparation, and to aid in defending classification decisions when challenges arise.

1. Summary

1.1 What, when, where, and why descriptions

1.2 Allocation of a unique growing area name and number

1.3 Abstracts of results and activities

1.4 Conclusions

1.5 Recommendations

1.6 Actions

2. Background information

2.1 Purpose, objectives, goals, and reason for the survey or study

2.2 General description of area including maps, and, if available, aerial photographs

Map showing location in N.Z., location in region, and specific water area

2.3 History of shellfish programme for growing area

2.3.1 Summary of sanitary survey history

2.3.2 Previous or recommended classification(s)

- Legal description
- Maps showing situation of growing area, houses, farms, land use, marinas, wharves
- Colour photographs, e.g., showing growing area, tide in, tide out

2.3.3 Management plan of "conditionally approved", "conditionally restricted" areas

- Opening and closing procedures and how these are communicated
- Basis
- Actions

2.3.4 Resources

- Shellfish species
- Distribution (map)
- Abundance
- Actions

2.3.5 Harvest practices

- Commercial
- Recreational
- List of lease or licence or authority owners
- Wet storage facilities (map)
- Seasonality
- Landings
- Relaying
- Depuration

3. Pollution source survey

3.1 Survey procedures

3.1.1 Who conducted, participated, and when

3.1.2 How was it done — procedures for:

- Shoreline reconnaissance
- Sampling procedures
- Sampling stations, map reference, how determined
- Collection — how?
- Analytical methods
- Laboratories — FDA evaluated?

3.2 Identification and evaluation of pollution sources

Explain all visible discharge pipes

3.2.1 Domestic wastes (maps)

- Septic tanks — statement on presence in catchment, and if adjacent to shoreline or watercourses, provide more detail on effluent disposal

  Attach house to house inspection form to Sanitary Survey Report
- Number and distribution
- Soil suitability
- Holding and pump outs — where disposed
- Impact on growing area
- Treatment plants or package plants or lagoons
- Location
- Size — operational and design capacity
- Type of treatment
- Outfall location
- Pumping station(s) — show on map and explain emergency provisions
- Bypasses
- Chlorination
- Backup equipment
- Hours of attendance and/or alarms
- Operational effectiveness — breakdowns, bypassing, chlorination practices, strength or quality of effluent
- Acknowledgment of responsibility
- Emergency notification procedures
- Location of sewer pipes if near to growing area

3.2.2 Stormwater

- Combined
- Drainage ditches, pipes, runoff

3.2.3 Industrial wastes

3.2.4 Radionuclides

3.2.5 Agriculture runoff

- Fertilisers
- Pesticides

3.2.6 Wildlife or domestic animals

3.2.7 Boat traffic and presence of houseboats

3.2.8 Marinas

The impact of marinas shall be calculated on the following assumptions:

- The occupancy rate of the marina
- An assumed percentage of boats which will discharge untreated waste
- An occupancy rate of at least two persons per boat
- A discharge rate of 2 x 10^9 faecal coliforms per person per day
- The wastes are completely mixed in and around the marina
- Closure is based on a theoretical calculated faecal coliform of 14 MPN per 100 ml
- Closure is based on the volume of water in the vicinity of the marina

3.2.9 Non-point pollution sources

4. Hydrographic and meteorological characteristics (maps)

4.1 Physiography (description of body of water)

4.1.1 Physical description: width, length, depth

4.1.2 Channels

4.1.3 Rivers

4.1.4 Passes

4.2 Tides

4.2.1 Type

4.2.2 Amplitude

4.2.3 Tidal exchange rate

4.3 Rainfall or runoff

4.3.1 Amount, summary of last 5–10 years

4.3.2 When, seasonality

4.3.3 Frequency of significant rainfalls

4.3.4 Rain gauge reference points

4.3.5 Heaviest fall in last 5 years

4.4 Winds

4.4.1 Strength

4.4.2 Directions

4.4.3 When, seasonality

4.4.4 Effect of wind in tidal estuaries, harbours, inlets.

4.5 River discharges

4.5.1 Volumes

4.5.2 Seasonal

4.5.3 Discussion on time for river to rise or fall after heavy rains and time for rains to reach river gauge

4.5.4 River height gauges

4.6 Currents

4.6.1 Tidal

4.6.2 Wind driven

4.6.3 Flood

4.6.4 Times

4.6.5 Dispersion or dilution

4.6.6 Effects of ocean currents on growing areas in bays, harbours, inlets

5. Water quality studies

5.1 Description of programme

5.1.1 Sampling station (maps), reason for selection

5.1.2 Minimum sampling plan required under adverse conditions including comment on wet weather surveys, time taken for bacterial levels in water to return to 14 faecal coliforms per 100 ml, and time taken for shellfish to return to 230 faecal coliforms per 100 g.

5.1.3 Sample collection, handling, and transport

5.1.4 Analytical procedures

5.1.5 History of algae or diatom blooms in or adjacent to growing areas

5.2 Data presentation (tables)

5.3 Data analysis

5.3.1 IAS statistical criteria

5.3.2 Advanced statistical tests

5.3.3 Data presented in summary table

5.3.4 Include full calculations or statistics

5.4 Present results on:

5.4.1 Overall conditions

5.4.2 By meteorological conditions

5.4.3 By hydrographic conditions

5.4.4 By pollution events

6. Interrelationships of the foregoing factors

(Discussion of how actual and potential pollution sources, wind, tide, rainfall, etc., affect or may affect water quality)

6.1 Address the following:

6.1.1 Pollution sources as affected by meteorological conditions

6.1.2 Pollution sources as affected by hydrographic conditions

6.1.3 Potential pollution sources which may occur because of seasonal conditions such as holidays, stock sales, festivals

6.1.4 Adverse conditions caused by meteorological events

6.1.5 Adverse conditions caused by hydrographic factors

6.1.6 Data analysis confirming the interrelationships

6.1.7 Explanation of the causes of data variability

7. Conclusions

7.1 Recommended classification and harvesting criteria

7.1.1 Description of respective area for respective criteria

7.1.2 Maps

7.2 Recommendations

7.2.1 Monitoring schedule and stations, etc.

7.2.2 Comments, suggestions for future work

Appendix 2: Minimum requirements for performing shoreline surveys in shellfish growing areas

1. Survey assignment

1.1 The shoreline relevant to the growing area shall be identified in the map of the growing area catchment by an approved inspector

All shoreline survey data shall be documented and filed promptly with the Ministry

2. Examination of individual properties for pollution sources

2.1 The boundaries of the shoreline survey area shall be determined by an in-field investigation of the area topography and the proximity of individual properties to the growing area; this should identify for examination only those properties where the potential discharges of wastes (raw sewage, kitchen wastes, laundry wastes, agricultural wastes, etc.) may affect growing water quality

2.2 The location of each property with a pollution source adversely affecting the growing area shall be provided

2.3 If the property has a pollution source adversely affecting a growing area, one of the two notations listed below shall be made concerning its impact on water quality

2.3.1 Direct impact

- A pollution source having direct impact is defined as any waste discharge which has immediate impact on the growing area
- An attempt should be made to quantify the volume of the discharge

2.3.2 Indirect impact

- A pollution source having an indirect impact is defined as any waste discharge which reaches the growing area in a roundabout way
- An attempt should be made to quantify the volume of the discharge

2.4 All sanitary, industrial, or agricultural pollution sources shall be located on a map of the survey area

2.5 All animal farms shall be evaluated; the evaluation shall include the number and type of animals and, where relevant, the type and effectiveness of waste treatment systems

2.6 All marinas shall be evaluated in accordance with section 3.2.8 of Appendix 1

The survey shall comment on flocks of waterfowl, populations of wild animals such as deer, seals, penguins, and possums, and an estimation of their number, seasonality, and effect on the growing water quality shall be provided

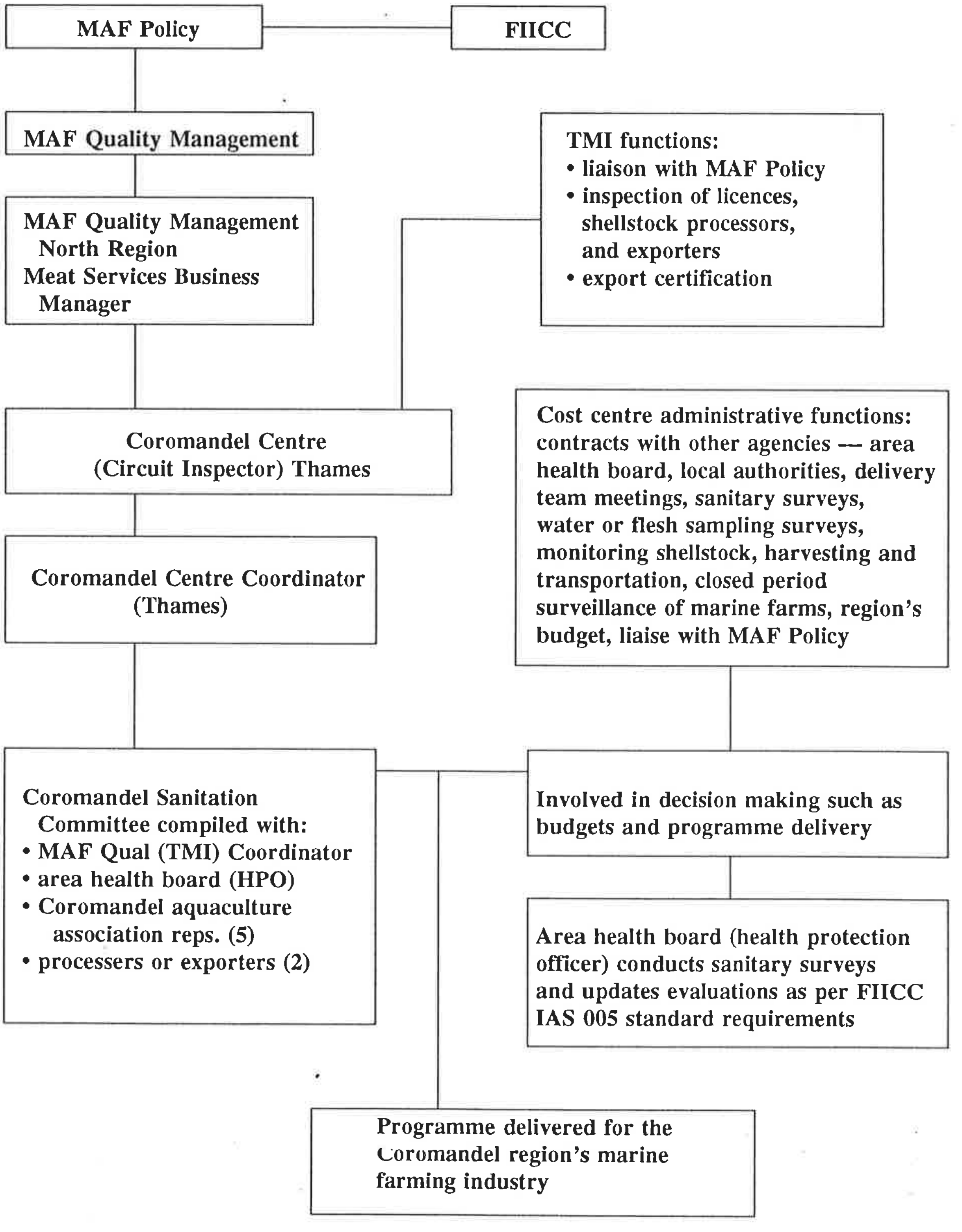
2.7 Drains, ditches, streams, and other watercourses shall be evaluated

2.8 Any other potential source of pollution which in the surveyor's opinion might influence water quality shall be evaluated and reported on

The surveyor shall provide a comprehensive map of the survey area identifying the location of each pollution source found

Appendix 3: Coromandel region operational structure

This diagram explains the management structure and responsibilities in delivering the region's Shellfish Quality Assurance Programme



Discussion

In reply to a question from Godsiff, Busby said that the water quality criteria for mussels in the Marlborough Sounds applied to oysters, but it was necessary to apply for a variation.

Barker asked about the heavy metal standards for New Zealand, and Busby replied that there were standards, though the standard for cadmium was revoked because the levels in Bluff oysters were so high. There was substantial variation of standards and inconsistency elsewhere in the world (e.g., the Australian states permit different levels); thus, it depended where you wanted to market your product. The standards issue was complex and not well established.

Hine commented that Foveaux Strait oysters had a high cadmium level (about 6 ppm), though it may be possible to reduce the level to about 4 ppm by holding them in clean water for 48 h (probably by cleaning out gut contents; the balance being bound, doesn't depurate). Superphosphate was suspected as the source of the cadmium, but highest levels of cadmium were found in the Chatham Islands (12 ppm), where application of superphosphate was low.

Levels in Tasman and Golden Bays varied from 3 ppm (surface) to 2 ppm (bottom), and levels of < 1 ppm may be achieved by depuration. Culture off the bottom may help lower cadmium levels.

The Department of Health has made oysters an exception, and there is no evidence that cadmium is a problem, but you need to be aware of it in case some restrictions are imposed here or on export markets. The 6 ppm in Foveaux Strait oysters is above Department of Health levels, but there was no difference in levels of cadmium in Bluff or Invercargill compared with the rest of the country, and cadmium levels are not elevated in people who eat lots of oysters.

Smith commented that cadmium levels in Wellington Harbour were below the level we wanted to reduce them to. Trials were needed in potential oyster farm areas to check levels on and off the bottom.

Hickman noted that growth of farmed oysters may be so fast there would not be enough time for cadmium to accumulate.

Marketing

R. Davidson

Trade Development Board, Wellington

Introduction

This product has the potential to be a winner.

According to an exporter of Pacific oysters, the dredge oyster has real export opportunity if we can overcome the *Bonamia* problem, and even more of an opportunity if the rest of the world cannot. I don't entirely agree with that opinion. Getting production under control is only about 20% of the journey for successful export marketing.

There are many variables that can influence the realisation of a product's potential, and I will discuss some of these under the broad heading of marketing.

What is marketing?

Marketing is one of the most misunderstood buzz-words. In my opinion it is a philosophical view of a business; where the business is tuned to the needs of the distribution channel, with the end consumer firmly in view.

An export marketing oriented organisation will, over time, move downstream towards the end consumer. Large industries, such as meat and dairy, have made this transition. Smaller export sectors, such as wine, are in the process of making it.

Marketing activities must be conditional or profitability oriented. Marketing alone will not guarantee success — many large marketing oriented businesses experience product failure frequently (1 in 20 of all new product launches fail).

There are some companies who are very successful without any apparent marketing activity; they are either very lucky, or they could be even more successful if they focused on their customers.

In summary, marketing is about being driven by the market place.

What marketing is not

Marketing is not finding a sales solution to a product that you have already produced. It is not the flogging off of 1000 t of cultivated dredge oysters. It is not going to a trade fair in Korea, appointing an agent, and sending him containers of product without knowing where the product is consumed.

If you think that you can set up the production side of this potential export item, and then look for a sales solution when there are sacks of product on the wharf, it is likely that you will have a failure, as opposed to a potential winner.

We could talk about what marketing is not for hours. It is important to realise that it is an upfront activity; it requires considerable planning and a huge amount of control.

Principles of marketing

Research

The cornerstone of understanding the market and the consumer is research. It doesn't have to be expensive and high powered, but it does have to be accurate and not leave too many gaps.

When I was preparing this presentation I went out to some of our posts and spoke to a couple of exporters about the potential for dredge oysters. The following is some of the feedback.

Hong Kong

- Korea, Canada, and New Zealand supplied 760 t of mussel imports in 1991;
- Hong Kong has an insatiable demand for seafood; a programme for dredge oysters would need to be well researched and coordinated;
- product should be fresh or chilled in a half-shell form.

Spain

- major market for shellfish;
- rock oysters are already consumed;
- control over Bluff shucking and poor quality aspects was raised as a concern.

United Kingdom

- appear to be French and U.K. dredge oysters on the market;
- EC produces about 200 000 t; there is a U.K. oversupply, and they export mainly to France;
- duty for New Zealand would be 18%, so it is likely that the Pacific oyster in the U.K. would be uncompetitive; dredge oysters may have some potential in the U.K., but the 18% duty may make them uncompetitive.

Japan

- Pacific oyster is popular in Japan;
- in 1991, 250 000 t were cultivated;
- product is not a luxury item; the meat is used in soups and stews, and it is sold for about NZ$30 per kg;
- top quality product is consumed raw on the shell;
- barrier to entry — Ministry of Health and Welfare test for paralytic and diarrhoeic toxins;
- retail for top quality oysters can go over NZ$100 per kg;
- no comment for live dredge oyster potential without further research.

France

- most commonly consumed live;
- imports of live oysters from New Zealand are not possible;
- in 1990, 144 000 t cultivated in France (98% deep and 2% flat);
- France imported 399 t of oysters in 1990, consisting of 73 t deep oysters, 17 t flat oysters (up to 40 g), and 309 t flat oysters (over 40 g) — mainly from the U.K. and, to a lesser extent, Ireland and the Netherlands;
- France exported about 6000 t, of which 468 t were flat.

Distribution

If the key success factors to buying property are location, location, location, then the key success factors to marketing are distribution, distribution, distribution.

With respect to dredge oysters, consideration needs to be given to:

- airfreight;
- seafreight;
- channels (brokers, importers, distributors, etc.);
- market representation;
- seasonality of supply;
- difficulty of changing distribution;
- access.

Product

Issues worthy of consideration here are:

- fresh versus frozen;
- quality (minimum standards, ISO 9000 accreditation);
- safety;
- product form (full-shell, half-shell, meat);
- the market sector (retail, food service, and manufacturing);
- adding value, what does it mean for this product?

Positioning

Perceptions of a product and the realities of the product are two different things. Marketing is about perceptions, not realities. Often consumers will pay more and show more loyalty to a product that is well positioned compared with a product that finds its own position.

Issues worthy of consideration here are:

- will you use the clean green backdrop of New Zealand?
- will you pitch the product at the premium end?
- what is the quality pitch?
- how will you protect this position, branding?
- is the positioning credible?
- does the positioning match product form and price?

Promotion

The famous marketing quote is "I know half my promotional spending is working, but I'm not sure which half".

There are many promotional options, and their effectiveness is very difficult to measure.

The options are:

- trade advertising;
- trade promotion;
- consumer advertising;
- consumer promotion;
- public relations;
- personal selling.

The questions that need to be asked include:

- what are the objectives?
- who are the segments?
- will it be a shotgun versus a rifle approach?
- what is the positioning line?
- is there a special story to tell?

Competition

Where will the consumer dollar be spent if it's not spent on your product? Where is it being spent now if your product is yet to enter the market?

The market place is a battlefield that will never stand still to allow you to get prepared.

Some of the issues worthy of consideration are:

- who are your competitors?
- what is their strategy?
- how will they react to you entering the market?
- what are the determinants of success in this market sector?

Pricing

Pricing is a key element in the marketing mix, and the one that will determine profitability for all concerned. The major criticism of New Zealand exporters is their ability to compete alone in export markets and leave money on the table.

Some areas worthy of consideration include:

- positioning objective;
- working back from the market versus cost plus;
- competitive position;
- everyone in the distribution channel must make a good profit.

Industry cooperation or competition

As an emerging export industry you are in a unique position to consider the degree to which you want to work together and the extent to which you will compete. It is very difficult down the track to decide you must cooperate when the exercise has become unprofitable because of weak selling. Industry structure is the framework that marketing must hang from. If it is weak, it will make the marketing job much harder.

Conclusions

There are five points that I want to reiterate in conclusion:

- your product appears to have potential;
- there are several marketing issues which need consideration before you go too far down the road;
- the production of a product ready to export is only about 20% of the task;
- 1 in 20 new product launches fail;
- planning and control will be fundamental to your success.

Discussion

Barker said that with increased volume the market price may drop or duty may be imposed. Davidson replied that planning and cooperation were imperative.

Hay asked whether exporters who developed a market should set the market. Davidson said that fellow New Zealanders shouldn't compete over a market — inshore competition should be minimised to maximise offshore benefit.

Davison asked who would support a dredge oyster marketing board as a single marketing authority like the Apple and Pear or Dairy Boards. Some support was expressed, but Hearn said that the main problem in the foreseeable future was production, and that must be solved first. For that, an innovative approach and the problem solving ability of individuals was needed to maximise development of production. Then, because there would be a very receptive market, entrepreneurial flair would be needed rather than a single desk seller.

In response to questions about the acceptability of the product on the European market, Hine replied that it was too strong in flavour for Europeans, who preferred a milder species, so we wouldn't get the top price, though the price would still be good.

Disease control

P. M. Hine

MAF Fisheries Greta Point

Introduction

In 1979 French oyster growers decided to improve the genetic diversity of their flat oysters (*Ostrea edulis*) by importing European flat oysters from the west coast of the U.S. The stock they chose to import was known to experience intermittent mortalities, and it was known that these mortalities were associated with the presence of a "microcell" in the oyster's blood cells (Katkansky *et al.* 1969). Despite this, live oysters were moved to France, and before the presence of these microcells was detected, stocks were moved on to the Netherlands and Spain. After massive mortalities in the bays around northwest France, where the oysters had been laid, a microcell parasite was identified and described as *Bonamia ostreae* by Pichot *et al.* (1979). As well as spreading rapidly around the Atlantic coast of mainland Europe, with movement of infected stock, it spread to England (1982) and Ireland (1983), and was in the Mediterranean by 1991, appearing on the Italian Adriatic coast by 1992.

In early March 1986 the fishers of the Bluff oyster fleet found a large area of freshly dead oysters (*Tiostrea chilensis*) in the central western beds of Foveaux Strait. Subsequent examination under the electron microscope showed an organism similar to, but different from, the European *Bonamia*. In early 1991 many flat oysters (*Ostrea angasi*) died in Port Phillip Bay, Victoria, and in December 1991, after further mortalities, the cause was identified as a species of *Bonamia* similar to the species in New Zealand oysters. A study along the Victorian coast showed infection in Port Phillip Bay and Westernport Bay, the two prime sites for aquaculture. Examination of fixed oysters showed that *Bonamia* had been in Port Phillip Bay since at least 1986. In early 1992 flat oysters (*O. angasi*) from Georges Bay and Triabunna, Tasmania, were examined, and they contained a *Bonamia*-like organism that was almost certainly the same as the New Zealand and Victorian parasites. No mortalities have yet been reported from Tasmania, but the severe pathology observed in a few oysters suggests mortalities will occur. The *Bonamia* in Victorian and Tasmanian oysters may have caused the collapse of the oyster fisheries at the end of the 19th Century, or it may have been introduced to those stocks with the shipment of live Bluff oysters to those waters early this century (Dartnall 1969).

The rapid spread of *B. ostreae* in Europe coincided with the widespread destruction of flat oyster stocks, with only very limited recovery. This destruction was not due solely to *Bonamia*, but in France was preceded by large mortalities caused by another protist (single-celled) parasite *Marteilia refringens*. These and other pathogens have caused the demise of flat oysters and the alternative culture of Pacific oysters (*Crassostrea gigas*) in Europe. This has raised the price of flat oysters to record levels, whereas Pacific oysters command a much lower price that is unlikely to rise if culture worldwide causes a glut.

If we are to benefit from the world shortfall in the supply of flat oysters, we must consider how this may be achieved, both in relation to problems created by serious disease and the acceptability of the product on world markets. This paper, therefore, considers: firstly, the presence of *Bonamia*; secondly, the other potentially serious diseases of oysters in New Zealand; and thirdly, international certification for, and regulation of, disease.

The presence of *Bonamia*

Bonamia is a single-celled parasite specific to the blood cells (haemocytes) of oysters. The New Zealand species has a well defined annual pattern of infection (Hine 1991a, 1991b). From September to early November it occurs at very low levels just below the basement membrane of the gut, suggesting it entered before September through the gut wall. From about November onwards, oysters spawn, first as predominantly males, and later (January-April) as mainly females. At the end of each spawning haemocytes enter the gonad to take in and remove unspawned eggs or sperm. *Bonamia* begins dividing in haemocytes from November onwards, coinciding with the entry of haemocytes into the gonad to re-absorb, mainly male, products. This re-absorbed material probably acts as an energy source which the parasite exploits to grow and divide.

By January *Bonamia* is abundant in most tissues, but it is the second, predominantly female, spawning that causes rapid proliferation of the parasite population. This is because Bluff oysters have a low fecundity; only about 15% spawn. Most oysters that develop eggs re-absorb them, and this appears to be the main energy source utilised by the parasite, and it provides for the massive proliferation. Mortalities occur from January to May, peaking about March. At this time oysters shed millions of *Bonamia*, either by death and decomposition, or through the gonad, kidney, gills, and gut (in descending order of occurrence). After May unshed parasites develop to larger forms, but these die off at the end of August. The few parasites seen from September to November are probably new infections acquired from parasites shed by other oysters during January-May.

Once inside a haemocyte the parasite breaks down and absorbs the haemocyte cytoplasm and grows and divides until up to 16 *Bonamia* are clustered together inside the haemocyte membrane. The membrane then breaks, releasing 4–16 *Bonamia*, which are then ingested by other haemocytes. The host oyster produces more and more haemocytes to contain the infection, with the result that it stops growing and reproducing. If the host oyster does develop gonad products, *Bonamia* will use that energy source for its own proliferation. Therefore, as well as causing tissue damage, *Bonamia* kills by exhausting its host.

In New Zealand *Bonamia* is known only from Foveaux Strait (FS), Port Adventure (PA), Port Underwood (PU), Tasman Bay (TB), and Wellington Harbour (WH) (Figure 1). It is known to cause disease in natural stocks of oysters in FS, and when held under artificial conditions at PU and WH. The parasite may be endemic and ubiquitous in all regions, or it may have spread from FS to other sites with the movement of infected stock earlier this century. Under certain, poorly understood, conditions (pathogenic strains, host starvation, stress?), the parasite proliferates and causes disease and death. Movement of infected stock is more likely to be the major cause of national spread of this disease than transmission between oyster beds.

From work done on *B. ostreae* in Europe, it is known that *Bonamia* is passively transmitted from oyster to oyster by water currents, and that the infection is hard to detect for 3–4 months after transmission. There are several anecdotal accounts of distances over which the parasite may have been transmitted, but no hard data. It has been shown that success of infection is dose dependent. A single *Bonamia* can establish infection, but this is rare, and the higher the initial dose the greater the likelihood that infection will occur. However, even an initial dose of 10 000 *Bonamia* results in only 40% infection (Hervio 1992). Therefore, because the parasite passively transmits downcurrent, and particle numbers per unit volume of water would be rapidly diluted, successful transmission is most likely to occur when large numbers of heavily infected oysters are close and upstream, and least likely to occur when infected oysters are at low densities, distant, and not directly upstream.

There is no evidence of a resistant stage that may lie in mud for years, to excyst when conditions become favourable, although some findings seem to suggest this. From studies using tray culture of *O. edulis* in the River Fal, Cornwall, it has been shown that infection first appears in the trays nearest the bottom. This may be due to other factors, such as water currents carrying the parasite from nearby wild stocks. Other evidence that may suggest a resistant stage comes from the movement of *Bonamia* between the inland seas of the Netherlands. After the flat oyster industry collapsed in the Yerseke beds because of *Bonamia*, new clean beds were developed in the Gravelingen, another inland sea. Before the oyster dredgers were moved from the Yerseke beds to the Gravelingen beds they were thoroughly steamcleaned. Despite this, the infection appeared in the Gravelingen about 4 months after the dredger movement. Rather than this being due to a resistant stage that survived steamcleaning, infected oysters may have been transferred unnoticed.

Bonamia is a parasite of flat oysters (*Ostrea*, *Tiostrea*), and does not infect Pacific or rock oysters (*Crassostrea*) (Pichot *et al.* 1979, Grizel *et al.* 1983, Bougrier *et al.* 1986, Dinamani *et al.* 1987, Jean-Chagot 1989). If infected oysters were stressed by handling, changes in temperature, removal from water, etc., the parasite levels would increase markedly. When flat oyster haemocytes normally ingest microorganisms they kill them with oxygen radicals from a respiratory burst, or with oxygenating enzymes, and then degrade them with enzymes from granules (lysosomes) which fuse with the phagocytic vacuole containing the parasite. When *Bonamia* is ingested the respiratory burst is suppressed (Jean-Chagot 1989, Hervio 1992), and once in the haemocyte the parasite modifies the wall of the phagocytic vacuole, preventing fusion of enzyme-containing lysosomes. The haemocytes of Pacific oysters efficiently kill *Bonamia* (Jean-Chagot 1989), and establishment of infection depends on the number of infective particles ingested by flat oysters (Hervio 1992). Therefore, co-culturing and intermingling flat and Pacific oysters should reduce the risk of bonamiasis in flat oysters. Although studies on *O. edulis* farming in France do not support this (Robert *et al.* 1991), further trials are warranted.

Another approach to the successful farming of flat oysters in the presence of *Bonamia* may be the selection of *Bonamia*-resistant stocks. For many years American oyster farmers have been able to buy American oysters (*Crassostrea virginica*) bred for resistance to *Haplosporidium nelsoni* (MSX), a parasite that is very similar to *Bonamia* (Ford 1988). Techniques have been developed for challenging *O. edulis* with different levels of *B. ostreae* to determine the dose that kills 50% of oysters (Hervio 1992), and stocks with elevated survival rates can be bred from survivors. Recently, flat oysters from Otago Harbour (OH), Tasman Bay, and Foveaux Strait held under the same conditions at Mahanga Bay in the MAF Fisheries hatchery showed different survival after *Bonamia* infection. Stocks from Otago Harbour survived slightly better than Tasman Bay oysters, and they survived much better than Foveaux Strait oysters. Tasman Bay oysters in field samples do have very light *Bonamia* infections; however, unlike the situation in Foveaux Strait, no mortalities have been reported from Tasman Bay stocks.

It would be premature to say that stocks in some parts of the country are naturally resistant to the parasite. They may be more tolerant, rather than resistant, and therefore able to carry heavy parasite burdens that slow growth and halt reproduction. Alternatively, they may be resistant because they are slow feeding and slow growing, with reduced feeding rates allowing more efficient destruction of incoming infective particles. In addition, oysters that are tolerant of, or resistant to, *Bonamia* may have unaltered, or increased, susceptibility to other pathogens (Chintala & Fisher 1991), and therefore disease as a whole needs to be considered.

Other potentially serious diseases of oysters

At present there are 11 known diseases or parasites of New Zealand flat oysters, other than *Bonamia*, of which 2 (coccidiosis and larval fluke infections) cause sterility and/or death. Distributions given below give known occurrence, though the lack of a record does not necessarily mean lack of occurrence.

Coccidiosis

Coccidiosis is caused by a group of single-celled parasites that have three phases to their life cycles. These are: merogony, in which merozoites are produced by division; gametogeny, in which male and female forms are produced; and sporogony, which follows gametogeny and gives rise to sporozoites. These stages may occur in one or more hosts. There appear to be three different coccidians which infect New Zealand flat oysters. One undergoes gametogeny and sporogony in the kidneys in March-May and appears to cause no harm to the host oyster. A second coccidian is known only from stages of sporogony near the gut wall, is rare, and appears harmless. The third coccidian occurs as merozoites throughout all host tissues, but particularly at the base of the gills, and is often abundant. Because only merozoites are known in the latter coccidian, and only gametogeny and sporogony in the first type, they may be different stages of the same species.

Merozoites of the third coccidian occur in oysters from FS, PA, PU, TB, WH, OH, Picton (Pn), and the Chatham Islands (CI). At all of these sites, except FS, most oysters contain few merozoites, which do not appear to cause harm. Occasionally, oysters are seen with moderate to high levels of infection, associated with connective tissue damage and reduced fecundity. In FS many oysters have moderate to high infections, and from January to May very heavy infections occur in which about 30% of cells seen under the microscope are merozoites. In the latter instance, the oysters are sterile, and tissue damage is widespread and so severe that recovery would be impossible. Such oysters are very small and unmarketable. Field studies suggest that 5% of commercial-sized FS oysters die from this disease each year. It appears that oysters spawning as males after mid summer are most susceptible, though assessment of sex is difficult with fecundity so severely reduced.

As with *Bonamia*, the parasite occurs in blood sinuses and haemocytes, which accounts for the systemic tissue distribution. Although coccidians are ingested by haemocytes, they are not destroyed, and they probably utilise haemocytes for growth and division. The co-occurrence of *Bonamia* and the coccidian at very high levels in FS oysters, and their common utilisation and destruction of haemocytes, must exacerbate the energy drain on the host oyster. This energy drain initially causes reduced fecundity, which may progress to sterility and death. However, there is no evidence that an oyster heavily infected with one of these parasites is more susceptible to heavy infections by the other parasite.

Larval fluke infections

Digenean flukes are a group of multicellular parasites of a wide range of animals which utilise different hosts during their life cycles. In New Zealand, larvae of the fluke *Bucephalus longicornutus* infect flat oysters during the early part of their life cycle (Howell 1963), use shoreline fish such as rockfish (*Acanthoclinus quadridactylus*, *Tripterygion* sp.) as secondary hosts, and have scorpionfish (*Scorpaena cardinalis*) and stargazers (*Kathetostoma giganteum*) as definitive hosts (Howell 1966, 1967). It is likely that other fish may act as hosts; although spotties (*Pseudolabrus celidotus*) taken near oysters with a high prevalence of larval *Bucephalus* did not contain the parasite (my unpublished data).

Once the larval cercariae have invaded the oyster, growth occurs at the expense of the oyster, causing parasitic castration and death. The parasite replaces host tissues, so that oysters appear plump, though they are heavily infected. These plump parasitised oysters do not taste noticeably different to most consumers.

Bucephalus has been observed in oysters from FS, PA, OH, PU, and TB, and it is probably ubiquitous around New Zealand. The prevalence of infection with *Bucephalus* is usually low, but the degree of parasitism of individuals high, in natural infections. However, the highest prevalence observed (42%) over several years of study was in oysters held in lantern nets at PU, which may indicate that *Bucephalus* can be a problem when oysters are cultured in moderately enclosed bodies of water containing many individuals of several fish species. It may be possible to control or eliminate *Bucephalus* from culture by breaking the life cycle. Physical separation of hosts would achieve this, but more research is needed to better understand the life cycle.

Other parasites and diseases

As well as *Bonamia*, the three coccidians, and *Bucephalus*, New Zealand flat oysters contain:

1. rickettsial infections in basophilic bodies between the epithelial cells of the digestive diverticulae (DD) (FS, Pn, TB, CI), particularly in Golden Bay and Tasman Bay in September-October;
2. a microsporidian parasite (*Microsporidium rapuae*) near the gut wall (FS, PA, OH, PU, Pn, TB);

3. an *Ancistrocoma*-like ciliate in the DD (FS, PU, TB);
4. dense cells with enlarged nuclei in the DD epithelium (FS, TB);
5. dysgerminomas and seminomas (FS);
6. nematodes in the gut (CI);
7. copepods (possibly *Pseudomyicola*) in the gut (Pn, TB).

The international regulations and certification for disease

Flat oysters are likely to fetch much higher prices on overseas markets than on the home market. Before New Zealand can sell flat oysters overseas, likely barriers to trade must be identified and overcome, and for molluscan shellfish, particularly flat oysters, the biggest barrier will probably be disease certification. The problem is complex, because it involves different agencies and different attitudes, depending on the product being marketed.

Currently the regulatory authorities with controls on disease are the Office International d'Epizooties (OIE) and the European Inland Fisheries Commission (EIFAC) of the Food and Agriculture Organization of the United Nations (FAO): EIFAC has disease control provisions, but, as its name suggests, is primarily concerned with freshwater fish; OIE is concerned more broadly with the international spread of serious animal diseases, and to facilitate this it has two lists of diseases of concern. List A contains the most serious animal diseases that are also of concern to humans, e.g., anthrax; list B diseases are also serious, but not to humans, and there are 11 list B diseases of shellfish. Of these, 7 infect molluscs (*Bonamia ostreae*, *Bonamia* spp., *Haplosporidium nelsoni*, *Marteilia refringens*, *Marteilia sydneyi*, *Perkinsus marinus*, and Iridoviruses), though Iridoviruses may soon be removed from the list. These lists cover not only live animals, but also animal products that pose a risk. The problem is that, though *Bonamia* is listed, there is currently no agreed reliable method for diagnosing *Bonamia*.

The European Community (EC) are due to harmonise their policies on issues that include disease control by 1 January 1993. Currently each country has its own regulations, which in some instances are based around the EIFAC and OIE regulations. In order to be complementary to EIFAC and OIE, while drafting a separate EC policy, the EC have been considering three criteria for inclusion of a disease in EC regulations. These are:

1. the disease organism must be impossible to treat;
2. it must occur in limited geographical areas;
3. the pathogens must be of significant socioeconomic importance.

Criterion 2 has become a sticking point in regard to marine organisms. Whereas geographical distribution can be easily defined in fresh water, few if any of the marine diseases being considered for control have a defined distribution. This is complicated by the lack of reliable diagnostic procedures for most marine organisms. It is calculated that it will take at least 2 years to overcome these problems. In the interim, certain requirements have been clarified.

1. It will be the responsibility of **exporting** countries to determine the occurrence and distribution of serious disease in marine species to the satisfaction of the EC. For wild stocks this means monitoring exploited wild populations; for farmed stocks it is likely that at least 2 years inspection of 20% of the farms must be carried out at 6 monthly intervals.
2. The receiving country must make its own decision on whether or not to accept the consignment.
3. Laboratories must have facilities and staff with relevant expertise to a standard set by the EC. International inspection is likely to be introduced.

These requirements will affect only live animals and animal products that pose a risk. However, to achieve top prices it will be necessary to sell fresh product, and that will require certification. The other alternative is to process the product in a way that negates risk, but that will reduce product quality and value.

It is unlikely that the EC will implement controls until reliable diagnostic methods have been developed. A promising enzyme-linked immunosorbant assay (ELISA), intended for *Bonamia* diagnosis, has proven inaccurate and been abandoned. Effort is now being concentrated on producing a reliable DNA probe. Until the interrelationships of the *Bonamia* species in Europe and in the South Pacific have been clarified, it would be naive to assume one, or even two, probes will reliably detect all *Bonamia* species. There is, therefore, some urgency in our acquisition of such techniques and technology.

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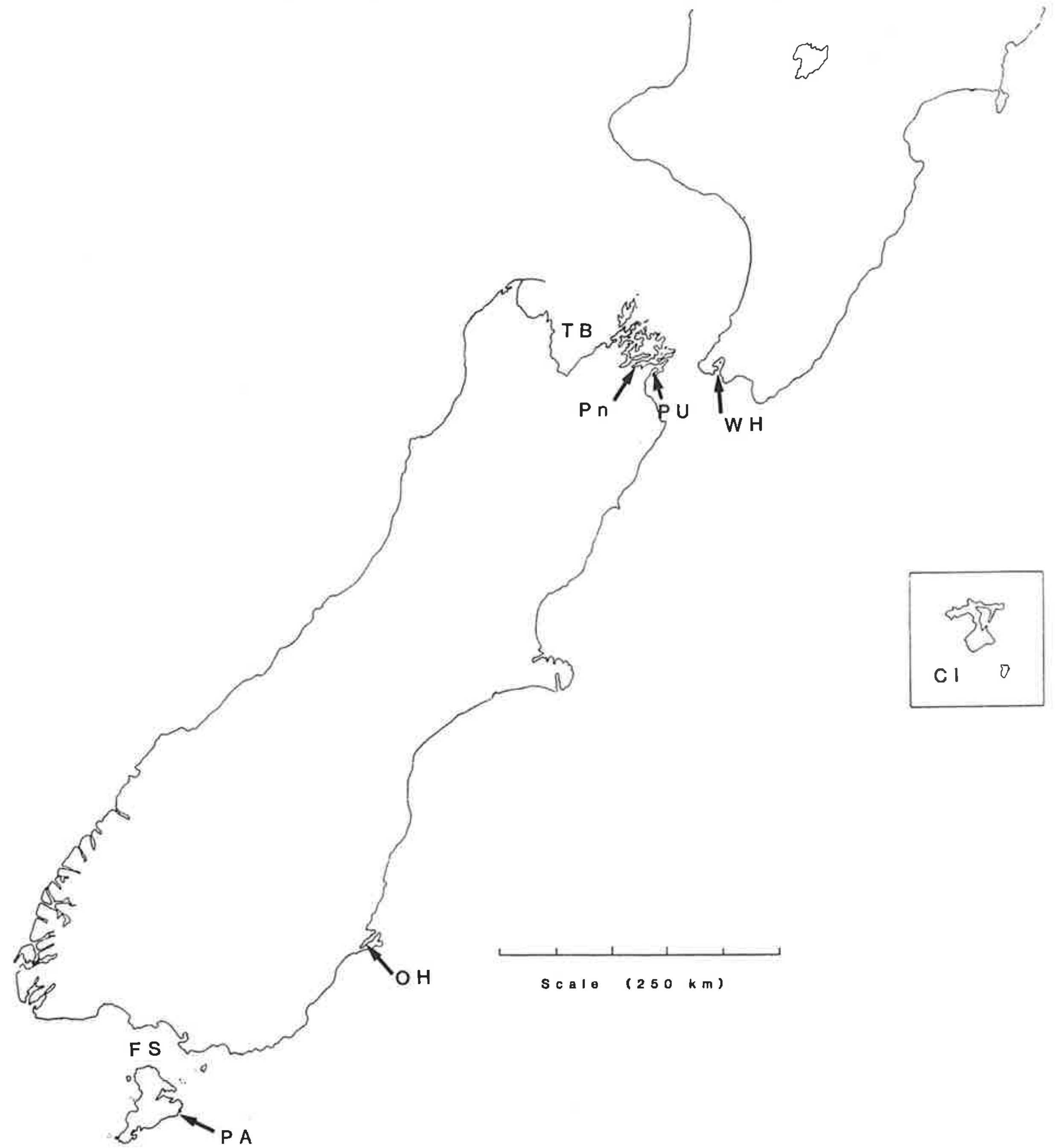

Figure 1: Sites examined for the presence of *Bonamia* and other diseases. (TB, Tasman Bay; Pn, Picton; PU, Port Underwood; WH, Wellington Harbour; CI, ChathamIslands; OH, Otago Harbour; PA, Port Adventure; FS, Foveaux Strait.)

Discussion

Dawber asked whether the costs of testing for certification to export to the European market could be incorporated with sanitation costs. Hine replied that he couldn't say, but it would benefit everyone if certification were streamlined. The EC requires that 20% of farms be tested. The New Zealand Government can chose which farms are tested, and they only need be those exporting to the EC.

Busby commented that if the industry wanted the same standards for local and export produce, it could impose them; MAF wouldn't. However, the end result could be the imposition of high costs to meet one specific market.

Hine commented that the EC intended setting up an inspectorate, but funding was not yet established. Our trading partners set the rules, and they were not defined yet.

Curtin said that there may be a (perceived) problem with exporting dredge oysters grown in an area other species are exported from. Hine noted that there was no fear of transmission of *Bonamia* from dredge oysters to Pacific oysters.

Hine commented that he could foresee people trying experimental culture at various sites, and we would then be able to identify the critical factors for successful culture. Problems were too area specific, and it was not possible to predict what they would be; however, MAF Fisheries would be able to assist with the resolution of problems. The French have built one laboratory and are building another in an attempt to solve problems associated with *Bonamia* — they have spent about $NZ10 million on it. The Canadians and Tasmanians are also extremely interested in culture of dredge oysters, i.e., there is great potential for culture. Hine said that *Bonamia* was the only disease problem now. He said that there was likely to be a continued decline in the level of *Bonamia* in Foveaux Strait as oyster stocks are reduced.

General discussion

The day's topics were reviewed briefly to decide on material for discussion. It was recognised that changes were due with respect to legislation and management of aquaculture and that farmers would be notified of these changes through the normal channels. In addition, there was a need for further information on export and health requirements to be made available to marine farmers before substantial investments were made in flat oyster farming.

Spat supply was seen as the critical issue for the development of the industry at this stage. Without a reliable supply of spat, farmers are unable to test ongrowing methods, growth rates, cadmium levels, and the disease risk from *Bonamia* in farmed oysters. Related to the issue of spat supply is the movement of stock, either adult broodstock or spat, and the perception that some stocks may be resistant to *Bonamia*. There are two basic options for spat supply: collection of wild spat and hatchery production.

Wild spat

Hearn felt that wild spat collection would not provide sufficient spat for a farming operation. His experience with collectors showed that it was possible to collect spat, but only in low numbers per collector. He suggested that an alternative low technology approach was to set up adults in a tank system and surround them with spat collection surfaces. This had worked, but he had encountered problems in removing the spat from the collectors for ongrowing, and found a high postsettlement mortality. Hickman said that the problem with catching wild spat was that they settled very quickly. Some early work in Foveaux Strait had shown that it was possible to collect spat by placing collector surfaces near adult oysters at the appropriate time of year (Hickman 1986). However, he also reported a high postsettlement mortality and that there would be difficulties in controlling settlement densities. Collection of wild spat might be less of a problem in Tasman and Golden Bays, where flat oysters had been shown to produce some larvae with a pelagic stage (Cranfield & Michael 1989).

Hatchery supply of spat

Spat had been produced by Hickman at the Mahanga Bay hatchery. However, because *Bonamia* had been detected in the hatchery during part of MAF Fisheries ongoing monitoring programme, no flat oysters could be transferred from the hatchery to other sites. This event had changed the original aim of having Mahanga Bay supply spat to farmers. The aim now is to develop a low technology method for spat production, which will allow farmers to set up small hatcheries and supply spat for local farms.

Some discussion was held on the possibility of setting up a small hatchery in the Marlborough Sounds to supply spat for this region. There was concern that it might not be possible to get the necessary water rights and set up a hatchery in time to produce spat for the forthcoming summer. In the longer term this would be necessary. Hearn commented that there were many suitable buildings available in the Sounds for a low technology hatchery. Hickman said that adult oysters should take only a few weeks to condition and spawn, so it might be possible to set up a small facility in time for this summer. Smith pointed out that MAF Fisheries would not be able to fund the setting up of a hatchery, rather the funds would have to come from private sources or regional grants. However, MAF Fisheries would be able to provide technical advice and support to set up the hatchery and the necessary stocks of microalgae and adult broodstock.

Two other options for a supply of hatchery seed for the 1992–93 summer were explored. Firstly, Dawber raised the possibility of using a closed-circulation system at the Mahanga Bay hatchery to avoid possible *Bonamia* infections from the local water supply. It was felt that the cost of setting up such a system to produce sufficient spat for farmers was likely to be prohibitive. In addition, Hine said that the current disease tests were not able to detect the presence of *Bonamia* in spat, so no guarantees could be given as to the disease status of spat produced by this method.

A second option was to produce spat at the AquaBio Consultants hatchery at Mahurangi by using local adult broodstock, if the area could be classified as *Bonamia* free. MAF Fisheries would have to carry out disease tests on adult flat oysters from Mahurangi before allowing the transfer of spat from this hatchery. Individual farmers would explore this option with Ms Hay once MAF Fisheries had carried out the necessary disease tests. The MAF Fisheries hatchery at Pukapuka was not likely to be suitable for flat oyster spat production because of the periodic supply of low salinity water, but it might be possible to grow microalgae at this hatchery to support spat production in the space-limited hatchery run by AquaBio Consultants.

Transfer of stock and *Bonamia*

Movement of oyster stocks around the country is controlled under the Animals Act 1967. Regulations are being drafted to control the movement of flat oyster stocks under the Biosecurities Bill. Before oysters are transferred, it will be necessary to demonstrate that the area is free of *Bonamia*. Hine would require about 100 adult oysters per locality to test for *Bonamia*. The oysters would need to be sampled before September while the parasite is prevalent. The tests take about 2 weeks of laboratory time. Hine was asked which areas should be tested for *Bonamia* and which might provide disease-free stock. The areas that have not been tested are Akaroa, Mahurangi, and the Marlborough Sounds. There was a need for a further sample from Otago Harbour, where *Bonamia* had not been detected. *Bonamia* had been found in Tasman and Golden Bays, but at a low level, and it was not causing significant mortalities. Bates said that there had been spat settlement in Akaroa, but they didn't know where the adults were, and consequently could have trouble providing adults for *Bonamia* tests.

In response to King's query about strains of *Bonamia*, Hine said that there appeared to be more than one strain. He also pointed out that there appear to be strains of flat oysters as well, and that there were some similarities between the New Zealand flat oysters and the stocks in Tasmania. A taxonomic study was needed to resolve the status of these oyster stocks. Dawber pointed out that it might be disadvantageous to the industry to transfer stock around the country. It was possible that *Bonamia*-free stock might carry other diseases not currently tested for, and that these diseases would be transferred inadvertently around the country.

It was agreed that industry personnel would collect oyster samples from Akaroa, Mahurangi, Marlborough Sounds, and Otago Harbour before September to send to Hine for *Bonamia* testing. The results would be sent to all those at the workshop.

The workshop concluded with Smith thanking everyone for their participation, particularly the speakers for their thorough overviews of their specialist subjects.

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