lack of oxygen, virus infection, adverse water temperature, and pollution.

A "named peril" policy pays when loss is due to a peril listed in the policy. One named peril policy on the market covers: mortality caused by: pollution; theft; malicious acts; predation; storm; lightning; tidal wave; collision; sudden structural failure of equipment; freezing; operating error; fire damage; desalination change in concentration of the normal chemical constituents of the water.

Deductibles
Mortality policies include deductibles — the amount paid by the insured, pay as the result of a loss. For example, the deductible on most inshorewate insurance policies is $250. The insurance pays any covered loss over $250. Mortality insurance deductibles are more complex. Deductibles may be a percentage of the loss. A 20 percent per loss deductible means that, if the total of the loss was $100,000, the insurer would provide a payment of $80,000 and the insured would pay the remaining $20,000.

Some farms carry a deductible of 20 percent of the value at risk. So, an operation with $1,000,000 worth of fish would be responsible for paying $200,000 before the insurance carrier would pay a loss.

Another common policy provision is a "franchise clause," which means, for example, that the loss exceeds 80 percent of the value at risk (per cage or per site, depending on the policy). If the loss is below the franchise percentage, no insurance would be paid. If the loss is above the franchise percentage, the policy then pays 40 percent of the loss. The percentage required can be from 50 to 90.

Valuable Help
Insurance companies can offer a variety of services to their clients, including providing advice and assistance to farmers in areas such as evacuation and predator prevention. An insurance company's expertise can be invaluable. For example, a farmer may have never experienced a major disease problem, but the insurer may have dealt with such a problem many times. Both the insurer and the insured can benefit from a specific, consistent loss-control program.

Cage-Site Marine Coverage
Ocean-based aquaculture has unique property exposures. Equipment located on offshore sites are subject to the perils of the sea. Equipment to be covered at sea-gen sites include cages, nets, predator controls, harps, feed and to-be-used equipment. This equipment should be insured under a special policy. Feed and harvested fish can also be insured.

Workers' Compensation Insurance
Aquaculture workers are subject to the hazards of their workplace. Some states treat fish farmers like other agricultural employees and allow for workers' compensation coverage. Some states require workers' compensation coverage. Coverage will vary by state. There are also issues of federal law to consider. Jones Act coverage is needed for workers on "vessels under navigation."

Hull Protection & Indemnity Coverage
A wide variety of marine vessels are used in aquaculture — from small crafts to floating processing operations. Hull insurance policies provide protection for damage to the vessel. Protection and Indemnity coverage provides liability coverage. This policy can provide the coverage needed for vessels under Jones Act.
Challenges to the Offshore Culture of Shellfish

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Abstract

The recent declines in approved shellfish-growing waters throughout the United States have been paralleled by similar declines in the harvest of wild and natural stocks of molluscan shellfish. The conditions have declined so significantly, in fact, that the continued degradation of water quality in these areas that are still productive, along with continual overharvesting and disease may eventually eliminate the wild harvest of shellfish.

Successful operations in Willapa Bay, Oregon and Folly Beach, South Carolina have recently shown, however, that sustained levels of production can be achieved through the use of aquaculture. But ensuring this success requires access to both high-quality water and a land base. In addition, the exclusive use of parcels of land and water is often required. This may conflict with existing recreational uses such as swimming, boating, fishing, and navigation.

In an effort to avoid these conflicts and find areas of cleaner water in which to grow their product, shellfish farmers are moving to offshore waters, employing new techniques in both cage and suspension culture.

Among the greatest successes of offshore aquaculture operations to date have been those in California, where abandoned oil rigs and anchored barges provide adequate habitat for the production of mussels, clams, and oysters. The sites are carefully monitored for pollution contamination, and sufficient water samples are taken and tested to meet the guidelines of the National Shellfish Sanitation Program (NSSP). Although
other states, such as Massachusetts are prepared to permit those offshore operations, they have been discouraged in other areas.

The reasons are varied, with the most complex relating to the rules and regulations governing aquaculture in federal waters. Other questions being examined include which agency should have the lead in implementing the operations, and who will be responsible for permitting and monitoring the operations once they are in place. In addition, issues have been raised regarding whether federal or state agencies will be responsible for ensuring the quality and safety of products landed from offshore culture, and who will conduct the additional monitoring efforts needed if harmful non-algal blooms occur. Finally, ocean farmers are extremely cautious about making major investments if they can neither obtain a lease over the water column in which they operate. Clearly, these questions and others will need to be addressed in the near future if offshore culture is to be ensured.

Trends in Australasian Open Water Aquaculture.

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Introduction.

New Zealand and Australia have substantial coastal waters with established aquaculture operations in both shellfish and finfish species. The combined efforts in both countries towards establishment of a viable open-ocean aquaculture industry is being driven by increased resource awareness, transition, recreational and environmental pressures, species biological considerations and increased importantly market demand expansion opportunities.

This paper will briefly outline the main Australian shellfish industry groups and one New Zealand group who are making the transition to exposed areas and identify key ingredients to both their successes and failures to date. For all these industries the development of open-ocean aquaculture is seen as a logical progressive step backed by considerable experience and capital resources.

Industrial aquaculture is developing in both countries with greater coastal production units using increasingly larger areas of water space and based around capital-intensive infrastructure, economies of scale in production and low labour inputs. Shallow-water aquaculture systems in this type of industry environment exhibit high levels of specialization, automation, and mechanization in order to be internationally competitive.

Background.

The main Australian species farmed in the marine coastal zones of both countries and their respective production values in US dollars are:

223
Species | US $ millions | Culture type
--- | --- | ---
Scallops | 25 | Fluted enhancement and eastern culture
Oysters | 55 | Intercultural rack culture and longline culture
Mussels | 85 | Longline culture
Pearl Oysters | 100 | Longline culture
Prawns | 25 | Control ponds
Salmon | 70 | Cage farming -- sheltered waters
Bluefin Tuna | 95 | Cage farming in semi-exposed and sheltered water
Total Value apparent | 520 million US dollars in the 1990s period

There are some remarkable Australian successes (and failures) within each of these industry groupings. In general terms it would be fair to say that aquaculture's steady development, growth and direction on both sides of the Tasman Sea, which separates New Zealand and Australia, has been achieved within a wide range of ever-changing regulatory requirements.

In this paper I talk extensively of "Australian aquaculture" as a single group but in reality the separation distance of 2000 miles between New Zealand and Australia represents a gulf in thought, attitude and environmental conditions, similar to those that exist between Canada and the USA or Norway and Denmark. As a New Zealander, or "Kiwi" as we are internationally referred to, it is extremely important to emphasize that at a country we work together voluntarily and that at the 1993 World Cup Off-San Diego in 1993, we were amongst the Australians said?

Today I wish to discuss five Australian aquaculture industries briefly, including our flannel group the southern bluefin tuna, which have the potential to move or do moving further offshore. The issue of how far each industry group will go to establish offshore aquaculture operations will depend on market and economic forces (opportunities, resource access pressures in the richer coastal zones), the biological requirements of the species, the development of appropriate industry infrastructure and the development of viable and effective technologies.

In virtually all Australian cases the benefits of remaining close to sheltered, semi-sheltered, and semi-exposed coastal regions will far outweigh the benefits of moving offshore into open exposed locations.

The additional question of whether a new aquaculture species (either shellfish or finfish) can successfully enter the aquaculture arena through direct development in an open ocean environment without the benefits of a gradual increase (by-passing) being assessed must be critically considered. This brings up another point where aquaculture information and understanding must improve (by experience) in order to allow better predictions as to the risks of both research and financial failure at a significantly higher cost.

So, why go? And who will go? Today I would like to relate a personal viewpoint based on my experiences and observations gained from the New Zealand and Australian aquaculture industries.

Southern Bluefin Tuna, Thunnus macrocephalus

In the context of finfish, the single and most successful example of prolonged open ocean aquaculture is the Australian Southern Bluefin Tuna industry based in Port Lincoln, South Australia. Duro in general a limited resource of this most magnificent southern ocean species, a high international market value, fluctuating markets and changing factors and a potential diminishing resource, the Aquaculture tuna industry in South Australia decided to commence the development of farming the species. This was seen as a logical step for the industry to capitalize on its established infrastructure and increase market returns from a restricted resource.

The Bluefin tuna are pampered with existing
visually from the wild, raised hundreds of miles through the wild open southern oceans in specially designed towing cages, transferred into aquaculture cages at the farming site and then sedentarily marketed using sophisticated handling techniques and technology transferred from both the Japanese wild fishery and existing aquaculture fish farms operations in Australia. Cage sizes are up to 60 meters in diameter and stocking rates vary from 2.5 kgs per cubic meter. This industry has grown over a sixty-year period to a tagged 1996 value of $95 million Australian dollars even though feed conversion rates are extremely high at 17 to 25:1 and there have been significant biological and management problems to overcome.

Some may say "this isn't aquaculture!" But in the context that they now have a five-year-old breeding development program for closing the life cycle of this tuna species, have developed a full aquaculture infrastructure through transfer of capital and technology to a new species and finally are successfully transferring them indoors enclosed water to open ocean conditions to meet the biological and expansion requirements of the industry, they have met many of the criteria previously stated.

In the Australian scallop fishery, industry similar successful transitions are being made in all recognized species.

New Zealand Scallop Industry, Nelson Region, Pectenenucleus laevis

The New Zealand southern scallop industry centered in Tasman Bay, Nelson (the center of the Southern Islands) commenced a scallop enhancement re-stocking program for the Pecten species during the late 1970s and early 1980s after a complete failure of the local scallop wild fishery. In the mid-1980s, Japanese zosteraeformae technology for wild spat collection had been modified, mechanized to a degree and implemented by the regionally focused scallop industry. The scallop aquaculture group involved with fisherman, generating companies, the Fisheries Department scientists, and Japanese scientific cooperation. Although the project initially focused on both longline culture of scallops as well as the potential for scallop bottom enhancement, the financial commercial focus was on a managed enhancement over the previously fished areas of Tasman Bay.

The end result is the re-establishment of a commercial scallop fishery within the Tasman region, which from a zero base now realizes approximately US$ 20 million annually in export value product. The enhancement project, which annually places out 300 substrate lines, 800 meters in length for scallop spat collection is owned and operated by both the industry processors and fisheries. The scallop spat seed is then distributed over areas designated by GPS positions within a three-year rotation along the sounds of the fisherman under contract to the Scallop Enhancement Company. The company pays the fishermen under contract and in addition has recently purchased their own specified vessel at a cost of US$ 1.5 million for the deployment and recovery of all area's, harvested, and scallop spat.

Certain key elements are apparent in this successful example of a regionally-based, industry-led aquaculture program and are paramount to long-term success. They are:

- Transfer of existing underutilized capital resources into an industry's development;
- Application of good science and technology to the program for economic and resource recovery;
- Community, regional, and government support for the project's outcomes;
- A valued quality product with both domestic and export potential;
- A stable biological environment for culture establishment; and
- Support from recreational fisheries for resource enhancement on a non-exclusive basis.

The last element is acquiring worldwide importance, in the writer's opinion, the days of claiming
exclusive resource access rights and claiming the moral high ground through extensive argument development have gone. Agricultural development in all areas and including open oceans must be developed from a long-term environmentally sustainable viewpoint and there must be direct spin-offs to recreational interests from the industry.

New Zealand Greenshell Mussel Culture Perna canaliculus and the Longline Systems

The development in New Zealand of advanced longline cultivation systems including extensive management and mechanization of the culture management process has improved markedly the potential of both shellfish and mussel culture systems for moving into offshore locations. In this section of my paper I wish to address the traditional bias of both these industries and then discuss in some detail the longline system themselves, which in the future may hold the key to development of other species in offshore locations. Both industries exhibit similar characteristics of growth based on market demand, sophisticated technology, a capacity for automation, and a transfer of capital resources and technology from established industries. The expansion is logically based on existing infrastructures, expertise, and is supported by a developed industry base.

New Zealand Greenshell Mussel Culture Industry

The New Zealand Greenshell Mussel Industry in 2000 produced approximately 5,000 tonnes. It now produces nearly 65,000 tonnes of product annually based around two growing areas: the Marlborough Sounds, at the northern tip of the South Island (47,000 tonnes) and in the Greymouth region (18,000 tonnes), located on the eastern part of the North Island.

The mussel industry growth has been based on 110 metre surface baggeage with a single packer top running parallel at the surface separated by 250 metre lines. 2.2 metres in length. Individual dropper ropes in continuously looped culture rope is then suspended in depths from six to 50 meters depending on bottom depth and tidal flow.

The culture system is highly mechanized with contract specialization now dominant at every level of the industry producing cost efficiencies far greater than single farm operators can achieve. For example, contract based, whether of processing or nursery type or both, is done by contractors using purpose built vessels in most instances and qualified professional divers where required. The authors themselves are made by specialist companies supplying solely to the mussel industry.

Recessing operations and harvesting are again contract specialist activities with sophisticated automation involved in increasingly larger capacity vessels. For instance, recessing contractors can now harvest and process up to 200 tonnes in a day using four people. Harvesting vessels are similarly capable of stripping, desalting, and washing up to 60 tonnes of fresh Green-Louise product per hour and have carrying capacities from 72 to 120 tonnes at deck level.

The most recent fleet additions in the Marlborough region is a fleet of the 29 metre twin screw aluminum barge with forward wheelhouse, crew of four to six. Average capacity harvesting rate on clean product, holding capacity on deck 120 tonnes and with tanks 12 to 14 tonnes fully loaded. Cost approximately NZ $1.9 million dollars.

The trend in all aspects of this industry has been one of economies of scale, increasing size of operators and capital investment, a reduction in the number of individual farmers and increasing company ownership due to the significant differences in cost of production between large and small operators.

The recent development of the industry started for Greenshell mussel cultivation has led to further improvement in longline technology suited to open water culture of mussels, shells, and other types of capture shellfish. Detailed trials using submerged single and double packers were undertaken to enable a more stable environment for capture shellfish.
Development of Australasian Open Ocean Oyster Culture Industry

This industry has in recent times benefited from many of the spin off effects of farming technologies developed for the New Zealand mussel industry. The oyster industry in both countries has traditionally been based aroundintertidal areas in estuarine conditions with occasional shallow water development for areas in protected shallow bays or flood tidal areas. The increasing influence of urban and industrial growth pressure from recreational users and risk of pollution is encouraging oyster growers to consider open ocean locations as an alternative development area where potential risks and conflicts are reduced.

Once again market forces and potential for significant industry growth are determining factors for an established industry possessing considerable resources, knowledge and experience. The ten of the oyster is seen both as a logical and legitimate step with the planned utilisation of existing resources such as vessels, experienced people and engineering capability, thereby reducing associated risks

For the Australasian oyster industry the question of economic viability will be based upon defining biologically suitable areas for oyster growing where natural algal blooms will promote the growth of both shell and meat consistent with acceptable market levels. The Australasian oyster production is focused directly at the international fresh shell market where shell quality and meat production yield a higher return. There are two suitable trends apparent in developing open ocean areas. Firstly, where open ocean areas are used for the intermediate step of culturing shell stock prior to using established intertidal areas for final finishing and secondly, for large volume production by using significant levels of automation and mechanisation. Not only do these approaches expand overall production volumes, they also promise specialisation with greater efficiency in the use of optimum growing areas.

Environment for enhancement of settlement of Giant shell mussel spat using specially designed "baby" polyethylene ropes. Unlike the Mollusca species or blue mussel, the New Zealand Perna species settles most effectively onto sedimentary films in stable low energy environments. Depths of 10 to 30 meters are being used. Management systems have been developed to handle the settlement phase. In the past three years this submerged double bag technique has been directly used to develop the more exposed farming sites and locations which previously were regarded as marginally economic or operationally unsuitable.

Increased farming in exposed sites has required development of vessels designed to handle the increased sea conditions and wind exposure. For this purpose a 10 meter 75 ton aluminium catamaran has just been launched for operating in the Golden Bay region, which regularly experiences 2.5 meter seas and winds gusting 30 to 50 knots. The vessel is designed to travel rapidly to farming sites when weather permits, harvest at 20 to 30 hectar per hour, and return to port before weather deteriorates. Harvesting is achieved through the centre of the vessel between the two hulls which gives added stability, easier vessel positioning to the line in rough sea conditions, and greater working safety plus protection for the crew from wave action. This vessel has an 8.9 meter by 12 meter working area and is designed to perform both line establishment and harvesting operations with a crew of seven.

The New Zealand mussel farming industry has driven development from inshore to offshore culture locations mainly based upon a logical progression evolved from growth at a viable market, 20 years of farming experience, parallel farming technology development, increasingly sophisticated automation, operational specialisms and associated capital investment at medium high risk levels to the investor. This momentum has led to 166000 tonnes by the year 2000 through increased utilisation of exposed farming locations. It is certain that they will succeed.
The Development of Open Water Oyster Culture Systems

Oyster culture operations in the intertidal area are primarily small, intermittent enterprises operated with low technologies and a minimum of authorization or mechanization. Harvesting, sorting, grading, and juvenile culture operations occur on plot sizes from three to 10 hectares acquired during low tide periods and are subject to random harvesting criteria to reduce risk of pollution from land-based activities. Seed supply can either be from wild or hatchery sources.

The development of subtidal oyster culture has seen usage of two different techniques. The older modified Japanese-type system involves oyster spat settlement onto shells or discs, which are in turn threaded onto a continuous or multiple dropper rope before attachment to the culture longline and growth through until final harvest. This style of low-intensity product management is more suitable for only species near rhizobacteria and reduces limited quantities of higher-priced half-shell product. The more recently developed submerged culture system is an advancement on the traditional intertidal, single seed style of culture. This system enhances the opportunity for mechanization, same day on-eminence operations, reduced costs of production and any risk of harvesting in nonoceanized areas, where rapid criteria have a minimal impact on shellfish operations.

The system is based on the culture of single-seed system on a growing unit consisting of up to 10 one-meter square trays separated by spacers and hung vertically beneath a horizontal mainline. At the water depth and the exposure of the fanning side increases, the culture unit can be suspened at greater depths beneath the surface to optimize growing conditions, reduce harvesting, or in open ocean concepts move away from the high-energy surface wave action in exposed locations.

In high-exposure areas with waves as four meters, oyster modules have been successfully deployed to eight meters depth in a dropper system without product exhibiting stress to growth. In the design of the dropper backbone system, four critical components have become apparent:

- Hoisting must be reduced to the bare manageable minimum to ensure that wave-induced lift or ‘bounce’ is minimized. From recent experience this is approximately 30% of the buoy profile exposed. Buoys should go through the sea, not try to ride it.
- Buoy attachment by way of a dropper rope to a submerged mainline backbone is the best solution, as this enables wave force energy to be substantially dissipated at surface level through horizontal deflection of the potential damaging forces. In addition, with pointed ellipse-shape buoys, the action of the buoy is considerably more gentle.

The additional 2.5-meter dropper rope from the submerged mainline to the oyster tray units enables the unit to move independently of both the mainline and the buoy. Horizontal forces are further reduced.

The single backbone for submerged oyster culture means that buoys are positioned in a parallel alignment to the mainline, in heavy seas the pull, or lift factors as the angle to the mainline, greatly reducing the direct lift forces, which cause vertical movement to the mainline itself. The mainline length and the dampening effect of the multiple tray units themselves then compound the drag applied to the mainline to remove any vertical lift component.

Both the submerged longline system adapted from the intertidal culture industry and the tray and system have greatly improved the potential of the oyster industry to enable fixed culture while still remaining internationally competitive in the world marketplace.

Summary of Major Trends in Open Water Shellfish Aquaculture

To conclude this paper I wish to briefly summarize the trends identified from the industry examples above, and which are increasingly apparent: