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THE ADAPTATION OF MARICULTURE PRACTICES IN RESPONSE TO SPILLED OIL

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ABSTRACT: *Oil spills may contaminate both mariculture facilities and livestock. Prevention of oiling should therefore be afforded a high priority. Given appropriate conditions, this may be achieved by the traditional spill response measures. However, a number of self-help response options are open to mariculturalists, that may avoid or limit the effects of spilled oil. These include the relocation of cages, transfer of stock, and early harvest, although such measures are only likely to be successful if a well-prepared contingency plan exists. The advantages and drawbacks of each of these approaches in the context of oil spill response are discussed.*

Introduction

Mariculture, the cultivation of marine species, is a long-established industry and its worldwide proliferation in recent years has made this a major source of seafood products. The grounding of the tanker BRAER, on the southern tip of Shetland, United Kingdom, in January 1993, amply demonstrated the effects that spilled oil can have on mariculture facilities, in this case salmon reared in sea cages. One outcome of the U.K. government's inquiry into the incident was a recommendation that a study be made of the protection of mariculture facilities from spilled oil. ITOPF carried out the study for the U.K. Marine Pollution Control Unit, now a part of the Maritime and Coastguard Agency.

Effects of oil

Cultivation of mariculture species generally takes place in the marine environment within floating cages, from floating rafts, and within the intertidal zone. Oil spills have a potential to contaminate these facilities and to affect livestock. This occurs either by direct contact of the oil with structures or the stock they hold, or by oil components in the water column causing toxic effects or tainting of the flesh.

Prevention of oiling is recognised worldwide from an economic and practical point of view, as being preferable to having to clean facilities (Figure 1) or to deal with contaminated stock. Whilst standard oil spill response measures such as booming or, if appropriate, the application of dispersant may be feasible, there are other options, such as adapting management or operating procedures used by the mariculture industry, which may help minimise contamination and financial losses.

Figure 1. Cleaning of mariculture structures can be difficult and time consuming.

Towing of structures

Towing floating facilities and the stock they contain out of the path of an approaching slick may be feasible if sufficient warning is given and if facilities are readily movable.

Cages. Moving floating cages is a complicated and delicate operation that can cause stress and damage to the stock and requires an alternative clean site with appropriate environmental conditions. Consequently, it is unlikely that cage relocation will be a viable option unless it has been well planned and practised in advance. This was amply borne out during the AMAZZONE incident in early 1988 in France, where exposure of the salmon to strong currents at the relocation site gave rise to physical abrasion to many of the fish which led to mortality. In addition, there is, of course, the risk that the spill will behave contrary to predictions and that oil will also reach the new location.

The technical feasibility of this option depends upon whether the operator has a powerful enough vessel to undertake the tow, whether the structure of the facility is robust enough to withstand any increased forces and whether the facility can easily be freed from its moorings.

Nevertheless, towing fish cages is a feasible operation and has been undertaken with success, notably in Norway, in response to threats of oil pollution as well as red tides. In some cases, cages are moved from one place to another simply to provide the stock of fish with more propitious environmental conditions. Furthermore, a device to increase the towing speeds and to minimise the stress on the stock has been developed by a French company. Although it has been used for the transportation of fingerlings from the hatchery to the cultivation zone, the system is still under development and not regularly used on cages of adult fish.

Shellfish cultivation on ropes and baskets. The problems with towing shellfish cultivation ropes and baskets are similar to those of moving cages. In addition, there is the potential problem of structural damage to the facility by entanglement of the cultivation ropes or baskets during towing, with subsequent loss of structures and stock.

Sinking of facilities

An alternative option may be to sink cages or structures below the sea surface, provided they do not foul on the sea bed. Purpose-built sinking cages are available on the market and designed to minimise the risk of damage being caused by rough surface conditions and by drifting ice. Their use in the face of oil contamination has yet to be proven.

The primary advantage of this technique over that of towing cages is that the local environment of the fish is not drastically altered. Such cages are designed to be sunk to depths of 5–10 metres and apart from possible temperature and current gradients, the stresses experienced by the fish are minimised. Additional advantages of this approach are that towing vessels, a sturdy framework, and rapidly detachable moorings are unnecessary, the risk of contamination of the stock would be greatly reduced and naturally dispersed oil would cause little damage to a cage in comparison to that inflicted by a surface slick.

Although sinking cages are used successfully in several areas of the world, their high cost, compared to the more common non-sinking cage, together with the additional cost of maintenance has led to a decline in their use. A cost-benefit analysis for each farming location would reveal whether the risk of oil damage justifies the higher costs incurred. The likely effectiveness of structures for shellfish cultivation which could be lowered below the surface when appropriate, might also be considered.

Stock isolation

Isolating stock from spilled oil may be achieved by establishing a physical barrier between the stock and the outside environment. Development work is underway in Canada and the U.S. using watertight bags or cylinders. As with sinking cages, costs may be prohibitive, especially as water pumping or purification, oxygen injection, feed supply, and waste removal are all necessary to keep the stock alive. Water quality must also be maintained if damage greater than that anticipated from oil contamination is to be avoided. Other inherent problems include the potential for entangling ropes and other parts of the structure when putting the protection in place, and additional forces on moorings and the structure itself due to the much larger surface area and increased current drag.

Whilst this approach would minimise the threat of tainting and effects of dispersed oil, the protective structure would be open to fouling and floating oil.

Transfer of stock

Where facilities are fixed, it may be possible to move the stock away from the oil, e.g., shellfish grown in bags (Figure 2). Primary requirements are sufficient warning of the threat and a suitable reception area. Transfer is labour-intensive, will inevitably be slow and costly, may be dependent on tides and daylight, and carries an attendant risk of stress and damage to stock.

The shellfish stock in a cultivation area will be adapted to a specific microbial ecology and may be carrying diseases. Transfer to another area could create the risk of spreading localised infections and may also place the populations transferred under new stress. Within the U.K., fish health regulations limit shellfish transfer from one zone to another, to minimise such risk. Delays incurred while awaiting appropriate authorisation to move stock during an incident may mean that action is not possible within the time available. These limitations are likely to make transfer feasible only for small stocks under ideal environmental and economic conditions.

Figure 2. Oyster racks in the intertidal zone of a Welsh estuary. Emergency relocation of this stock would be a labour intensive task.

Suspension of feeding

By suspending the feeding of farmed fish it may be possible to reduce the risk of animals coming into physical contact with oil at the water surface or becoming tainted through contamination of the feed. Although fish can normally be starved for a number of days with no other adverse effect than temporarily limiting growth, such measures must be used with care so as not to inflict more damage to stock than oil contamination may have caused.

Early harvest

Harvesting a proportion or all stock before it becomes oiled may be possible if the stock is in a marketable condition, but early warning of a threat is critical for success. For example, it is common practice with cultivated fish to stop feeding for up to 48 hours before any harvesting, to minimise the gut contents. The first priority after notification of a pollution threat should, therefore, be to halt feeding so that at least some stock may be harvested. In the event that the threat passes and early harvesting is not required, the fish can subsequently make up lost weight.

Harvesting and preparation of stock for market is labour intensive and requires other logistical support. In addition, some shellfish must be depurated for a period before sale. The inability to meet such requirements will make this approach difficult, but even if partial success is achieved, at least some mitigation of loss will result. At all times the benefits of such measures must be weighed against the possible consequences in terms of market confidence or over supply leading to slumping prices, that such a sudden harvest may bring.

Contingency planning

Contingency planning is vital to promote a successful response to any emergency. A good plan will minimise the delay in notifying those at risk from oiling, so allowing protective measures to be implemented. The limitations outlined above make planning particularly important if effects of an oil spill on fish and shellfish cultivation are to be minimised.

Conclusion

It is possible in some circumstances to provide a degree of protection to mariculture facilities from spilled oil. In addition to normal protective measures like booming, modification to management and operating procedures, coupled with careful planning, improve the chances of success. Some costly equipment like sinking cages or physical barriers, may be appropriate where the risk of contamination is high, however, the opportunities to use these approaches are likely to be rare. Further research into the viability of these options is therefore required before they can be widely recommended.

Biography

Tim Wadsworth joined ITOPF in 1991 and is presently a Technical Support Coordinator. Dr. Brian Dicks, a marine biologist by training, joined ITOPF in 1987, having previously been Director of the Field Studies Council Oil Pollution Research Unit in Wales, where he was involved with numerous research studies around the world on the environmental effects of oil pollution. He is currently a Technical Team Manager. Clément Lavigne is an agronomic engineer by training, specialising in marine products. He joined ITOPF in 1995 from the French research organisation CEDRE, where his work focused mainly on the problems of evaluating damage in fishery claims.

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