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Marine Mammals and Aquaculture: Conflicts and Potential Resolutions

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Abstract

Two main types of marine-based aquaculture come into potential conflict with marine mammals (and, in some areas, marine turtles and seabirds): (i) extensive raising of shellfish, such as oysters, mussels and shrimp; and (ii) intensive raising of finfish, such as salmon, sea bass and sea bream. The first takes up space in near-shore waters but does not generally require nets or cages that can entangle or otherwise hurt air-breathing vertebrates. It also does not require supplementary feeding, and therefore is not generally a major attractant for marine mammals and others. However, shellfish aquaculture puts extra nitrogen into the ecosystem, and can change local ecology where tidal and other flushing is minimal. It takes up extensive space in inlets, fjords and the like, and may compete for limited habitat access with foraging, resting, socializing and nurturant mammals. The intensive but generally more localized farming of finfish often requires supplementary feeding, and both the stock in holding pens and the feed serve as powerful attractants especially to pinnipeds (but toothed cetaceans, river and sea otters, marine turtles, and seabirds are often involved as well). As such, major problems are caused to the industry by destruction of gear and the target aquaculture species; and to the marine animals by shooting and other techniques, such as large-scale use of Acoustic Deterrent Devices (ADDs) and Acoustic Harassment Devices (AHDs). No technique has proved highly successful, and the widespread use of ADDs and AHDs is particularly problematic and largely untested. We recommend that owing to potential for entanglement, chemical and sound pollution, habitat loss or gross alteration, traffic, and changes in species interactions, all proposed development of marine aquaculture in nature should be subjected to initial evaluations and – as needed – scientific research relative to interactions between the food being raised by humans and the predators that attempt to take advantage of this. The loss of habitat to marine

mammals by both shellfish and fish aquaculture facilities needs to be investigated on a case-by-case basis.

Introduction

Aquaculture is an important industry that produces nearly one-third of the fish and shellfish products commercially available worldwide (FAO, 1999). Owing to the growth of the industry, the amount of habitat utilized along near-shore waters is increasing rapidly, and the number of conflicts between aquaculture and marine mammals is increasing as well. Aquaculturists estimate a loss of 2–10% of their gross production owing to marine mammal predation (Nash *et al.*, 2000). Most of this concerns marine-based aquaculture, except where riverine dolphins and lake seals co-occur with land-based aquaculture in such areas as the Yangtze River, the Amazon basin and several large lakes of Russia. A host of marine and freshwater birds and turtles, as well as river otters and other mammals, can take advantage of human-grown food so readily made available to these predators. In this chapter, we summarize marine-based problems related to marine mammals, with the realization that those of inland water systems can be similar; and recommend potential solutions to minimize conflicts between the aquaculture industry and marine mammals.

Shellfish Aquaculture

One form of aquaculture is that of extensive marine-based growing of shellfish (crustaceans and molluscs), such as mussels, oysters and shrimp. Such aquaculture takes up at times large spaces in inland bays and other waterways, and does not require supplementary feeding. Shellfish farms usually are developed in areas with sufficient water flow owing to tidal and other currents; and therefore potential pollution effects tend to be restricted in space, or only moderate over a large area (but see Páez-Osuna *et al.*, 1999; Kautsky *et al.*, 2000). Sea otters (*Enhydra lutris*), marine otters (*Lontra felina*) and walrus (*Odobenus rosmarus*) are the only marine mammals to habitually feed on shellfish. Therefore, there is usually no problem of marine mammal predation on the aquaculture resource, and little or no direct competition for the harvest between humans and the marine mammals in many parts of the world. However, in the Pacific Northwest of the United States and Canada, shellfish industries experience significant losses especially from river and sea otters. Also, faecal coliform counts from harbour seals (*Phoca vitulina*) have been known to contaminate the aquaculture beds (Nash *et al.*, 2000).

Extensive shellfish aquaculture competes for space in those areas where it occupies substantial portions of inland waterways. For example, in the Marlborough Sounds of the northern South Island of New Zealand, mussel and other shellfish farms are utilizing breeding, resting and foraging space formerly occupied by dusky dolphins (*Lagenorhynchus obscurus*), common bottlenose dolphins (*Tursiops truncatus*), Hector's dolphins (*Cephalorhynchus hectori*) and New Zealand fur seals (*Arctocephalus forsteri*). Dusky dolphins and other mammals are known to avoid the aquaculturally farmed areas, probably in large part owing to the numerous lines-to-buoys that may inhibit movement of schooling fish on which the dolphins feed, and make it difficult or impossible for the dolphins to efficiently aggregate their prey. A terrestrial analogy might be open-savanna lion (*Panthera leo*) prides being forced to chase and corral their prey in a forest. The planned expansion of mussel farming in the Marlborough Sounds indicates that near-shore habitat for marine mammals will become even more scarce, with presently unknown impacts on the health and survivability of the marine mammal species (Fig. 3.1). A recent illegal oyster farm (for harvesting of pearls) that was set up in the Shark Bay Marine Park of Western Australia dramatically affected known movements of Indian Ocean bottlenose dolphins (*Tursiops aduncus*), by excluding mothers and their calves from the farming area (Mann, 1999). Once the oyster lines were confiscated by the authorities, dolphins returned to their former habitat (Janet Mann, personal communication, February 2001).

It is not merely loss of space that causes habitat degradation. Marine mammals rely in large part on acoustic communication, echolocation (by toothed whales) and passive listening for prey in a world that is relatively opaque to sight (Richardson *et al.*, 1995). Extensive farming requires almost constant traffic owing to lighted-buoy maintenance, float and line maintenance, checking for the health and growth of the target crop, and harvesting. The vessels are a source of noise disturbance in formerly relatively pristine habitat, but amounts of habitat degradation and reduction of communication capabilities of marine mammals near shellfish farms are simply unstudied.

Where near-shore or on-shore shrimp farms have resulted in large-scale habitat disruption, coastal dolphins, porpoises, pinnipeds, manatees (*Trichechus* sp.) and dugongs (*Dugong dugon*) may be displaced or otherwise affected. The disruption is perhaps greatest for manatees and dugongs in the subtropical and tropical waters where coastal shrimp farming has led to loss of mangrove forest and other habitat (Dewalt *et al.*, 1996; Primavera, 2000; Páez-Osuna, 2001), but the above-mentioned effects on dolphins are also cause for concern.

Finfish Aquaculture

Intensive farming of marine or anadromous finfish is also of great concern. Such farming often requires supplementary feeding and the providing of medicines, with attendant problems of ecosystem change (Tovar *et al.*, 2000). For example, invertebrate benthic communities were affected at up to about 0.3 km distance radius from fish farm facilities in the North Baltic Sea even after several years of pollution abatement (Kraufvelin *et al.*, 2001). Similar

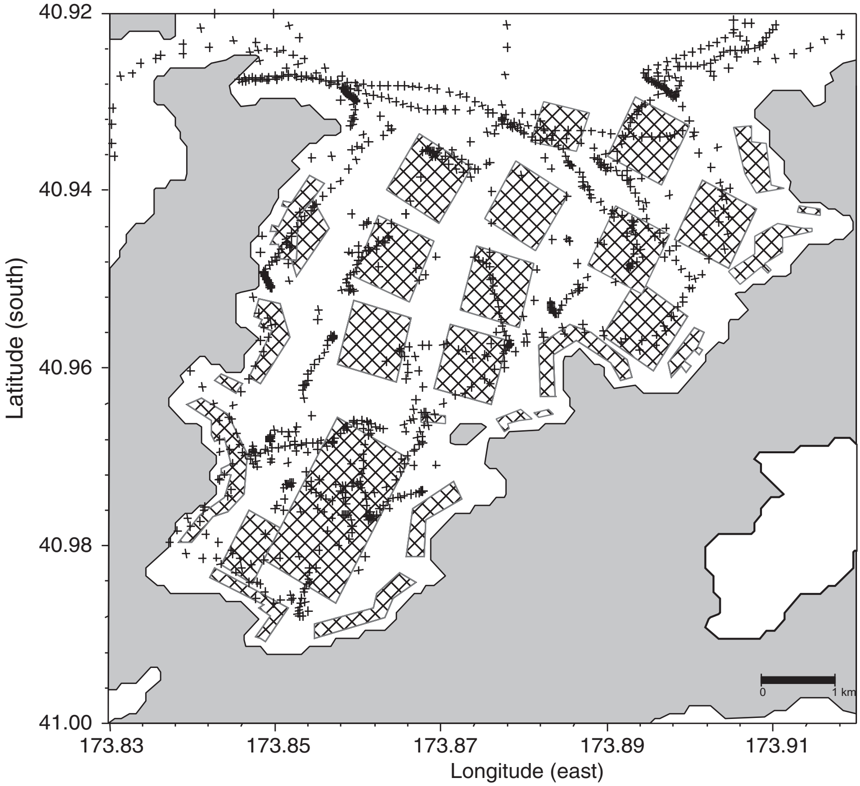

Fig. 3.1. Admiralty Bay in the Marlborough Sounds, South Island, New Zealand. Cross-hatched squares represent proposed shellfish farms, and near-shore cross-hatched longish patterns represent both proposed (in the west) and existing (in the east) farms. The small '+' marks represent dusky dolphin tracks ascertained during 6 total days of study in the winters of 1998–2000. Note that the existing near-shore farms in the east have no dolphin use overlap. It is clear that if even some of the proposed farms are built, dusky dolphin habitat use in the bay will be affected. (Data courtesy of A.D. Harlin and T. Markowitz, personal communication, February 2001.)

results were found for benthic communities down-current of salmon farms in British Columbia. The benthic infaunal ecosystem changes can displace feeding sea otters, near-benthic feeding dolphins and porpoises, and other organisms that rely on such benthic communities.

The providing of food and the very presence of fish being cultivated serve as powerful attractants to opportunistic dolphins and pinnipeds that normally feed on similar or the same fish stocks in nature. This sets the stage for large-scale competition between humans and marine mammals. In a well-known case study at the Ballard Locks, Seattle, Washington, only a handful of California sea lions (*Zalophus californianus*) may have been largely responsible for reducing an annual migration of 2400 steelhead trout (*Oncorhynchus mykiss*) – most of which were themselves raised by aquaculture techniques – to fewer than 200. The main culprit is said to have been a large male sea lion nick named ‘Herschel’, although other sea lions and human-caused problems of pollution and water quality degradation were likely factors as well (Gearin *et al*., 1986; Fraker and Mate, 1999). In fact, only 3% of 248 marked sea lions were found to enter the Ballard Locks and feed on steelhead salmon in 1995 (NMFS, 1996a).

It is difficult to blame human aquaculturists for attempting to dissuade the marine mammals (or other predatory vertebrates) from taking fish that are being grown at great expense, or that are themselves endangered and in need of human management (Fraker and Mate, 1999; Nash *et al*., 2000). Methods of dissuasion consist mainly of anti-predatory nets or other enclosures around finfish aquaculture facilities, noise-making devices intended to chase away predators, and shooting of the interlopers. The latter is almost always illegal, and has apparently been under-reported in the literature and to government agencies. By a recent web-based account of a salmon farm managed in British Columbia, Canada, 431 harbour seals, 38 sea otters, 29 sea lions, one harbour porpoise (*Phocoena phocoena*), 16 herons (family Ardeidae) and one osprey (*Pandion haliaetus*) were killed in a 4-year period. Because of the perceived threat of pinnipeds in the area, any seals encountered around the entire island harbouring the farm were also regularly shot. Their bodies were punctured to hasten sinking in an attempt to hide the evidence (Georgia Strait Alliance, 2000). While presumably a huge problem, especially for endangered populations of sea otters, actual numbers taken in most areas are unknown. Lethal force (generally by shooting) was legal in US waters until 1994, to control predators from damaging gear and finfish, but a more recent amendment of the Marine Mammal Protection Act now prohibits routine killing of marine mammals that prey on aquaculture facilities. However, individually identified pinnipeds that cause significant negative impact to the aquaculture site can still be lethally removed (Fraker and Mate, 1999).

Sporadic entanglement of marine mammals occurs in nets and enclosures designed to house finfish. While published records are few, bottlenose and common dolphins (*Delphinus delphis*) have been entangled in sea pens holding blue-fin tuna (*Thunnus thynnus*) off South Australia (Gibbs and Kemper, 2000); grey whales (*Eschrichtius robustus*) are at times entangled in netpens holding herring (Robin Baird, personal communication, December 2000); and an adult Bryde’s whale (*Balaenoptera edeni*) became entangled at a mussel farm in New Zealand (Chris Roberts, personal communication, December 2000). We assume that the latter entanglements of larger whales in aquaculture facilities are relatively rare events, and not as important as other aquaculture-related problems.

Finfish and Predatory Marine Mammals: Major Problems

Interactions between aquaculture and marine mammals are detrimental to all concerned. Marine mammals that take finfish in pens or after their release cause scarring of the fish, with presently unknown impacts on fish survivability and reproduction (Scordino, 1993; Harmon *et al*., 1994; Fryer, 1998); decimate the target fish (Fraker and Mate, 1999); increase fish susceptibility to disease or decrease growth owing to stress (Morris, 1996); and destroy gear, at times causing massive fish escape through torn pens (Pemberton and Shaughnessy, 1993). Losses to the aquaculture industry can be high, and have been estimated at many millions of dollars for the United States and Canada (Nash *et al*., 2000). For example, the US National Marine Fisheries Service estimated a loss of over US$50 million in 1 year in the Gulf of Maine alone (NMFS, 1996b), but we are not aware of accurate worldwide estimates. The marine-mammal-induced escape of finfish from aquaculture sites is also of ecological concern. Aquaculture stocks sometimes have commercially bred traits that could have unknown impacts on feral populations. Furthermore, escaped fish can transmit unknown diseases to other natural stock, which would increase conflict between aquaculture and fisheries (Morris, 1996).

Whenever a large problem exists, extensive efforts are instigated to reduce it. In the present case, predators that specialize on food from aquaculture facilities have been removed by trapping and shooting, deterred by firecrackers and electronic acoustic harassment or deterrence devices (AHDs and ADDs, respectively), deterred by such means as playing killer whale (*Orcinus orca*) vocalizations, chased by high-speed vessels, and given distasteful or emetic foods to eat (summarized in Buck, 2000). Large (and expensive) physical barriers also have been set up. The detrimental interaction is usually not alleviated completely, and much of the time the marine mammals are themselves harmed/killed during the interaction. This can present a problem to the predator in cases where populations are limited or endangered, such as for sea otters or Steller sea lions (*Eumetopias jubatus*), and a problem of at least perception in countries such as the United States, Canada, New Zealand and Australia, as major examples, where the public tends to view marine mammals as being special animals that warrant special protection. In the United States, this problem is particularly acute, as all marine mammals are protected from harassment by the Marine Mammal Protection Act of 1972, and its numerous amendments (Baur *et al*., 1999).

Mitigation Measures for Marine Mammal Conflicts

Aquaculturists have developed a suite of techniques to attempt to reduce marine mammal depredations where they occur. These can be classified under six major topics, from individual dissuasion to overall population-wide effects: (i) harassment; (ii) aversive conditioning; (iii) exclusion; (iv) non-lethal removal; (v) lethal removal; and (vi) population control. We shall briefly discuss each of these broad categories, and then make recommendations of our own from this list.

Harassment

Harassment of marine mammals in order to try to encourage them to stay away faces the general problem that one attempts to dissuade animals from obtaining a relatively easy and nutritious meal. The most primitive techniques of harassment consist of chasing the predators with fast boats, throwing firecrackers or other incendiary devices (seal bombs) at them, and shooting them with rubber bullets and blunt-tipped arrows. More recent and sophisticated devices consist of emitting loud and noxious underwater sounds. These tend to consist of killer whale vocalizations in areas where killer whales occur and might be predators of the problem-causing marine mammals, and of acoustic pingers or buzzers that make noxious sounds so loud as to cause discomfort in an acoustically sensitive pinniped or dolphin. The sounds are of two major types: acoustic harassment devices, which tend to have shrill-sounding (scream) frequencies of 12–17 kHz, and the similar acoustic deterrent devices, which are usually set around 10 kHz and have a piercingly loud (high decibel level) sound that is also designed to cause discomfort or pain at close distance. The use of these acoustic devices usually depends on the predator species. ADDs are considered to be of sufficient sound disturbance to deter most toothed cetaceans, who are believed to be more sensitive to sound than pinnipeds, while the increased frequency of AHDs mainly targets pinnipeds (Richardson *et al.*, 1995; Olesiuk *et al.*, 1996; Reeves *et al.*, 1996; Kraus *et al.*, 1997). Unfortunately, all such techniques tend to represent short-term solutions (Morris, 1996; Fraker *et al.*, 1998; Fraker and Mate, 1999; Nash *et al.*, 2000). Animals that are chased will generally return, and the loud sounds can even condition animals to perceive the acoustic signal as a dinner bell (Mate *et al.*, 1987; Olesiuk *et al.*, 1996): ‘There is food to be had in the region of sound discomfort’. Even the projected vocalizations of killer whales are ignored after some time, for acoustically adept marine mammals quickly learn to distinguish the real alarm from the false one, and at any rate habituate to sounds that are not followed by real danger (Fraker and Mate, 1999).

Nevertheless, AHDs and ADDs show reasonable success in certain areas, and are enjoying widespread use. They have intensity levels up to approximately 194 dB re 1 μPa @ 1 m, and are estimated to be heard in some environments at up to 50 km from source (Haller and Lemon, 1994). We deplore their use, because we believe that they put unacceptably intense noise into the marine environment without a clear understanding of their long-term effects on both target and non-target species. Such noise can reduce the communication capabilities of the very fish that are being grown by the aquaculturists (Tolimieri *et al.*, 2000), and the overall level of noise pollution can adversely affect animals, such as threatened harbour porpoises, that frequent an area, and may or may not be direct targets of the noise-making devices (Olesiuk *et al.*, 1996; Johnston and Woodley, 1998). Recent evidence (Morton and Symonds, 2002) indicates that high-amplitude AHD pulses designed to deter harbour seals from preying on salmon farms in British Columbia, Canada, displaced killer whales from their regular movements, and made large areas of formerly inhabited range unavailable to them (Table 3.1). The AHD pulses were apparently perceived as noxious by the killer whales (which are not harmful to the salmon pens), and the whales avoided the ensonified channels and bays in both the short and long term.

The intense sound production of ADDs also provides potential concern of injury to some marine mammals, and authorities are no longer advising the use of ADDs in Canada (Nash *et al.*, 2000). Furthermore, the so-called seal bombs are believed to deafen some seals, therefore making acoustic deterrent devices ineffective (Morris, 1996). Animals that undergo hearing loss due to exposure to acoustic devices may experience a decrease in their ability to capture prey in nature, thereby making aquaculture sites an even more important resource to fulfil their energetic requirements.

Table 3.1. The number of days that killer whales were detected in two separate areas of Vancouver Island, British Columbia. The area of the Broughton Archipelago was largely ensonified with AHD pulses during all of 1994–1998, and killer whale occurrence patterns were reduced in those same years. There were no fish farms or AHD/ADD sounds in Johnston Strait. (Data presentation after Morton and Symonds, 2002.)

Year	Johnson Strait	Broughton area Archipelago
1985	146	15
1986	166	30
1987	134	61
1988	132	29
1989	184	26
1990	160	30
1991	225	36
1992	175	33
1993	183	38
1994	207	15
1995	195	8
1996	183	4
1997	183	13
1998	186	9
1999	152	35

Aversive conditioning

The association of a food with a later illness was suggested some time ago as a means to induce taste aversion in predators (Garcia *et al*., 1955), and is used with some success by, for example, sheep farmers who feed sheep carcasses laced with lithium chloride (LiCl) to coyotes. The LiCl induces stomach cramps and vomiting in coyotes, and a single exposure tends to keep an exposed coyote from preying on lambs (Gustavson *et al*., 1974). The technique has been used with less success in keeping rough-toothed dolphins (*Steno bredanensis*) away from oceanic fishing lines, but with greater success in deterring California sea lions (Kuljis, 1984; Costa, 1986) and Australian fur seals (*Arctocephalus pusillus*; Pemberton and Shaughnessy, 1993). Nevertheless, success is not guaranteed: when there are many predators, a large number has to be trained for taste aversion, and LiCl may not always be the most effective or safest taste aversion agent (Cowan *et al*., 2000).

Exclusion

Exclusion of predators from fish pens is an obvious but not always attainable goal. Physical barriers have to be high and strong enough to keep large sea lions from causing damage to gear and fish. Nevertheless, construction of barriers has been instrumental in keeping smaller seals and fur seals from large-scale depredations, especially in Australia (e.g. Pemberton and Shaughnessy, 1993), and harbour seals from contaminating shellfish beds in Washington (Nash *et al*., 2000). Attempts at excluding predators with physical models (scarecrows) of other predators (i.e. life-sized models of killer whales) and with alarms at the pens or at nearby pinniped haul-out sites have been generally ineffective. The use of bubble curtains, a barrier of air bubbles produced from submerged perforated hoses, has been shown to acoustically mask surrounding environments (Würsig *et al*., 2000) and may deter predators from further enquiry into the enclosed aquaculture site. Bubble curtains have been largely untested, and their masking effects may be reduced in some high-energy areas (Tillapaugh *et al*., 1994; NMFS, 1996b).

Non-lethal removal, lethal removal, and population control

Removal of offending predators has been widely practised, and runs the gamut from capture and relocation, to capture and permanent holding in captivity, to lethal removal by shooting. The costly method of relocating animals only seems to delay the amount of predation since animals usually return to the same problem area. As with the problem of taste aversion, such removal becomes less effective when there are many predators, as is usually the case with pinnipeds and salmon farms in the Pacific Northwest. On the other hand, non-lethal removal can be highly effective where only several predators of a larger population in an area have learned to take advantage of (or have acquired a taste for) artificially reared food. Large-scale culling of offending predators, often termed population control or population management, can be effective but may be economically or legally difficult to implement. There is growing sentiment in the Pacific Northwest that California sea lions have reached numbers that exacerbate a host of human-use problems, with only one of these being aquaculture related. Consequently, various public sector concerns are arguing for culling of populations as a viable solution to pinniped-related problems (Buck, 2000). The problem is not easy to solve, however, as pinnipeds feed on many fishes and squid other than those commercially important or being raised by aquaculture. Some of these other prey themselves feed on the aquaculturally important food. When reducing the population of a predator (here, the pinniped), one invites unknown ecosystem changes, including a potential increase in predatory fishes that had been kept in check by the pinnipeds in the first place (Fraker and Mate, 1999).

Finfish and Predatory Marine Mammals: Suggestions for Solutions

While it is undeniable that especially pinnipeds cause major harm to some types of marine aquaculture facilities, we believe that there is much misperception of the extent and the reasons for the problem. As we view the larger picture, we realize that much of the problem stems from human overutilization and therefore a decrease in the natural food resources of the sea. Aquaculture is a partial attempt to remedy our unwise (or greedy) use of nature, and it is quite natural that the concentration of food resources should attract predators that have evolved to feed on marine prey. This somewhat philosophical argument does not directly help the interaction problem. However, a view of sharing the sea with the predators (or respect for them) might well be used to argue for including potential predation in the design and location of aquaculture facilities. For example, a clear relationship has been found with the extent of pinniped-related problems and distance of facilities from preferred haul-out or mating/pupping sites of the predators (Pemberton and Shaughnessy, 1993). The further away these sites, the fewer the problems (Table 3.2). In terms of foraging, the pinniped predators must invest more energy into travelling to and from the aquaculture site as the distance increases from their haul-out site. Therefore, the potential energetic gains from an aquaculture site decrease as the distance increases, and the site becomes less attractive than natural fish stocks. Distance from haul-out sites has generally not been taken into account in past aquaculture facility placement. Also, erection of high and strong-enough barriers against predation has not been universally factored into the cost of a facility, and quick fixes later on have proven generally insufficient.

Table 3.2. The number of Australian fur seal attacks on fish farm facilities in southern Australia, as a function of distance of the facilities from the pinniped haul-out sites.

Distance to haul-out site (km)	Number of seal attacks
19	108
22	63
45	18
38	11
35	10
60	3
40	2
48	1
40	1
33	0

A part of gauging the extent of predator problems is an accurate assessment of how many predators are involved, and what appear to be the costs of the predation. In Maine, for example, it has been found that rogue seals are often responsible for stealing fish and destroying pens. The removal of such a seal may mean no or very little pinniped problem to the facility for several months, until the next seal acquires a taste for this way of feeding (Morris, 1996). Unfortunately, such removal has generally been by lethally removing the animal, whereas it is possible (albeit generally more labour intensive) to capture and relocate the offending predator. The problem of a few animals creating at times intensive damage is very different (and is solvable) from that of many animals. Therefore, we recommend that: (i) the location of pinniped and other potential prey haul-out and foraging sites be investigated before placement of aquaculture facilities; and (ii) counting, individual identification, and perhaps even marking and radio tracking of select animals be conducted in areas where there is a problem. Only when we know how many animals are involved, can the most effective routes for action be investigated.

There are many different aquaculture facilities worldwide, and many different problems of predation. As far as marine mammals are concerned, we argue that success is most likely by: (i) physical exclusion; (ii) non-lethal removal; (iii) aversive conditioning; and (iv) acoustic or other harassment, as a last resort. The first two of these are known to be effective in many cases, and do not introduce other problems when properly carried out. The improvement of physical barriers between the environment and aquaculture farms seems to hold the greatest promise for a long-term solution (see Tillapaugh *et al.*, 1994; Reeves *et al.*, 1996). However, soft-material nets around finfish facilities are to be avoided, as they can entangle and kill marine mammals (Gibbs and Kemper, 2000), but thick plastic and steel fencing seems to create few entanglement difficulties. Non-lethal removal can be expensive, and is useful only when predator numbers are low. Aversive conditioning holds promise, but has only been tested sporadically and incompletely on marine mammals. Types and dosages of noxious chemicals to be given need to be worked out for enhanced safety and efficiency (Cowan *et al*., 2000). As for removal, it is unlikely that aversive conditioning is very useful when predator numbers are high. Acoustic harassment is probably the most widely (and variably successful) deterrent presently used. It has only recently become appreciated that the underwater world is of great acoustic importance to all sorts of fauna, and wholescale ensonification of this world is – in our strong opinion – unwise. We have recent evidence that such ensonification can have undesired effects on porpoises (Johnston and Woodley, 1998; Kastelein *et al*., 2000), dolphins and whales (Morton and Symonds, 2002) and fishes (Tolimieri *et al*., 2000). An automatic mechanism that turns on the acoustic alarm only upon detection of nearby predators could reduce the amount of noise emitted by ADDs and AHDs into the surrounding environment, and may be less habituating to predators than continuous transmission (Morris, 1996).

Conclusion

It is incumbent on marine aquaculturists and appropriate government agencies to requisition marine mammal studies before allowing new facilities to be placed. Extensive shellfish facilities can clog waterways and displace marine mammals, and intensive finfish facilities are likely to encounter unacceptably high levels of predator problems if located too close to haul-out sites, or other areas of traditionally high marine mammal use.

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