



A Fishy Business—Of Seals, Salmon and Fisheries in Scotland.

CETACEAN RESEARCH & RESCUE UNIT (CRRU)



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- Seals and salmon are charismatic fauna that are both regarded as species of conservation interest. However, seal depredation on commercial salmon stocks is a major issue for Scottish fisheries, who insist that the lethal control of seal populations is both necessary and justified.
- The current perception of increasing seal numbers as an argument for this persecution is nevertheless misplaced, as populations are evidently declining in many parts of the country and common seals, in particular, remain a significant conservation concern. Furthermore, the science suggests that the lethal removal of seals is likely to have little impact on existing salmon stocks relative to other major causes of salmon mortality, such as disease, predation by fish and recreational/sport angling, for example.
- Non-lethal measures of control (e.g. anti-predator nets, acoustic deterrents and other mitigative methods in development) remain the most suitable option for reducing the impacts of seals upon fisheries at this time, but these methods are not universally applied throughout the industry, and may be largely ineffective in coastal bag-net operations where animals continue to be shot indiscriminately.
- Problem or "rogue" seals can legally be shot under licence from Marine Scotland, but only as a "last resort". In the absence of repeated and skilled photo-identification however, even if a problem seal is successfully removed from a fishery, many additional seals would have to be shot thereby emphasising the futility of this endorsement.

- The current system of self-regulation within the industry is clearly inadequate and officials in offices fail to acknowledge the shortfall in reporting. Evidently, numerous kills go unrecorded, multiple kills may not be reported, unlawful sinking and/or dumping of carcasses deliberately occurs, plus there is no accounting for "struck and loss" figures (which may account for up to 50% of all reported clean kills).
- According to non-government and welfare organisations, the actual number of seals shot each year in Scotland may number in the several thousands, as local managers are often aloof as to what actually transpires within their fishery.
- An outright ban on lethal control may be desirable by many but, in terms of management, this could alienate cooperating stakeholders and simply exacerbate the current conflict situation. Instead, there is a need to strengthen existing regulation, to ensure mitigation is effectively taken up and licensees are held accountable for neglectful or unlawful behaviour. Revoking of licences needs to be realistic, whilst operators who continue to blatantly breach these regulations should be shut-down.
- The search for alternative, non-lethal control methods requires cooperation, trust and transparency between all interested parties (fisheries, scientists and animal protection groups alike). Recent advances in this direction are encouraging, but the interest in good profits over good practice by stakeholder beneficiaries is difficult to tackle in the present "self-regulating" industry, where formal monitoring is clearly impractical.
- With creative thinking and cooperation, it should be possible to create a new, eco-friendly industry worthy of this millennium which will consign seal-fisheries conflict to the past. Closed-

containment fish farms, for example, would eliminate the problem of wildlife conflict altogether (as well as reducing proximate environmental impacts), whereas ecologically-unsound and unsustainable coastal netting operations should be bought-out by fishing trusts or the Government and finally consigned to the Dark Ages.

- However, membership of existing management groups needs to be balanced to involve all interested parties—including animal welfare and non-profit interests who have previously been excluded from groups—as the current bias towards commercial interests is presently unacceptable.
- Building good relationships with the media and supporting constructive journalism remain important components in the developing management process. Educational programmes which support this process will further help to create a better understanding as to why certain decisions by policy-makers are made.
- Recommendations are subsequently made herein regarding the future of fish farms, coastal netting stations, and anglers / fisheries trusts respectively.



1—A CONFLICT OF INTEREST

Concerns over the impact of seals on UK fisheries has led to widespread killing over the last century. Attention has been largely focused on purportedly increasing grey seal (*Halichoerus grypus*) populations, but common or harbour seals (*Phoca vitulina*) are also culled locally by fisheries where they interact with farms and coastal netting stations. Under the Marine (Scotland) Act 2010, the shooting of both species is legally restricted by licensing. It is a condition of all licences issued that any shooting should adhere to the *Scottish Seal Management Code of Practice*¹, which sets out the general principle for fisheries stakeholders that seals should only be shot as a last resort in Scotland. Nevertheless, non-lethal methods of control are often insufficiently employed as a direct alternative to lethally shooting seals, and this is a particular problem in coastal set-net fisheries where modifications to nets are not yet compulsory or even possible at this time. According to figures forced from the Scottish Government under freedom of information laws, only 13% of Scottish fish farms were found to use seal exclusion nets in 2011/12—which directly refutes claims from the industry that these mammals are being shot by stakeholders only as a "last resort".

The perception of increasing predator populations as an argument for exploitation and persecution by fisheries may run true for grey seals in some parts of Scotland, but their rate of increase is now considerably slower than in the 1970s to 2000s, with declines in some areas ([SCOS, 2012](#)), while common seal declines in many parts of the country remain a conservation concern (Loneragan *et al.*, 2007). All the same, salmon fisheries maintain that both species have major, deleterious effects upon their catches and that population control is rightly justified. Yet science

¹ Marine (Scotland) Act 2010: Part 6 - Conservation of Seals. Available from <http://www.scotland.gov.uk/Resource/Doc/295194/0121503.pdf>

suggests that lethal removal of seals from large rivers and coastal netting sites by fisheries would have little impact on salmonid numbers relative to other causes of mortality, such as disease, predation by fish and even recreational/game angling, for example (Graham *et al.*, 2011b).



'The lethal removal of seals would have little effect upon salmon numbers relative to other causes of mortality'

Unfortunately there are many dimensions to this ongoing dispute, which presents a considerable challenge to the manner in which research into seal-salmon interactions and potential solutions to the problem are currently being addressed. For different reasons, both seals and salmon can be regarded as species of conservation concern. From a management perspective, seals are charismatic megafauna that provide 'cultural' services to wildlife tourists, tourism operators and the wider public for their recreational and intrinsic conservation values. Conversely, salmon provide 'provisioning' services when harvested by coastal netting stations for food, and 'cultural' value to anglers, angling guides, rod fishery owners and the public (Butler *et al.*, 2009). These services are subsequently seen as a trade off between one another (Figure 1).

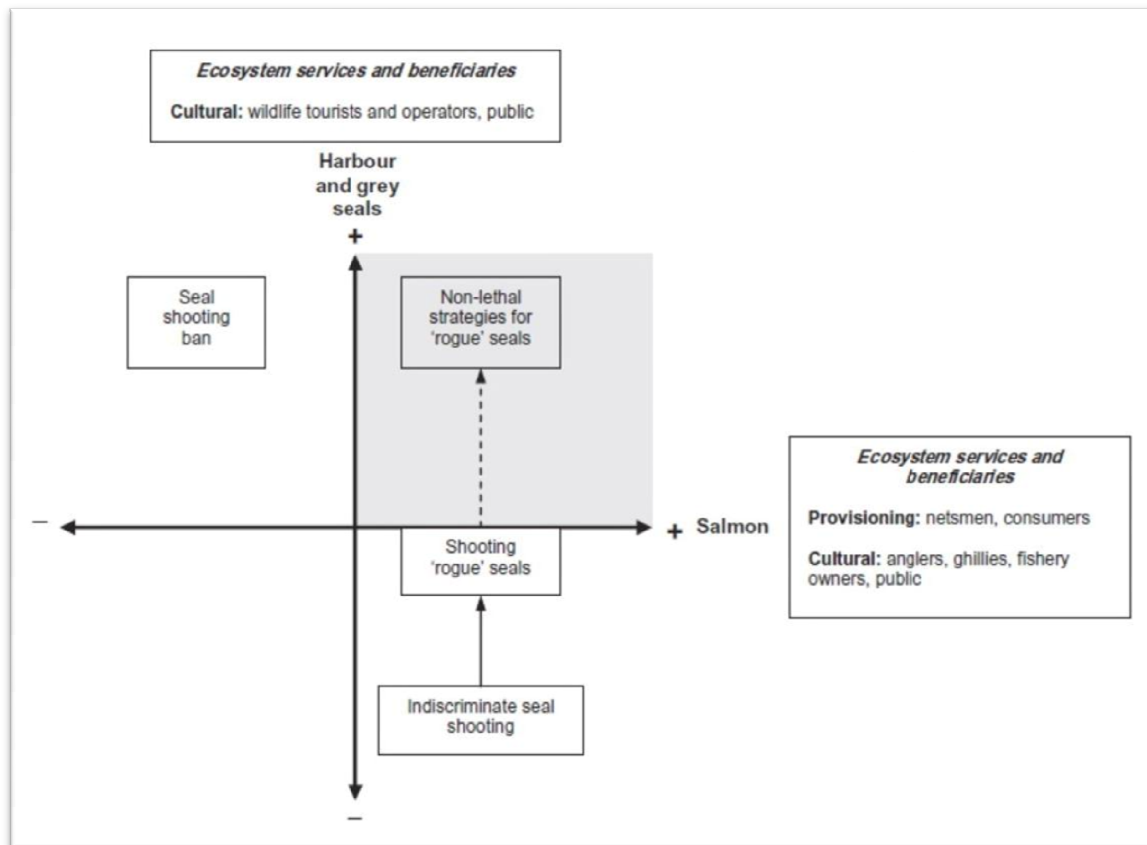
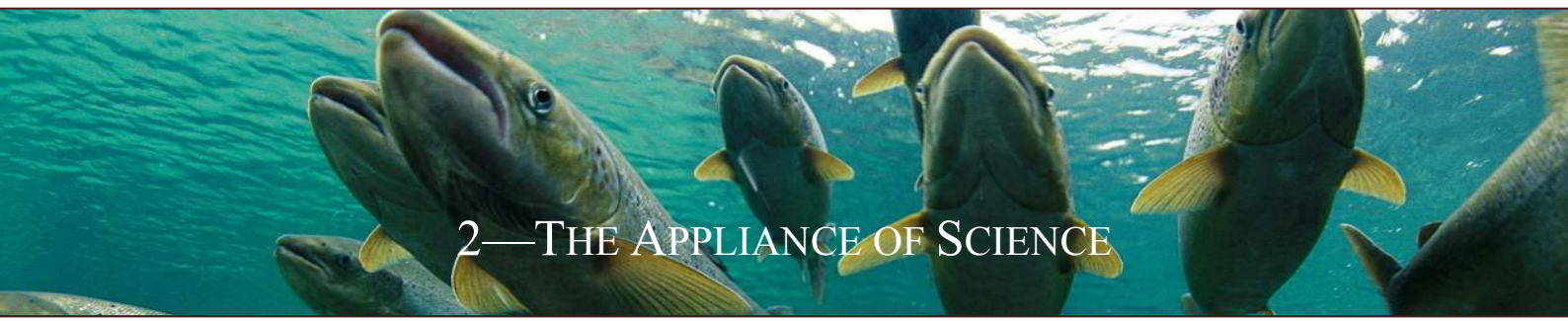


Fig. 1. A conceptual framework by Butler *et al.* (2009) illustrating the trade off between ecosystem services provided by seals, salmon and their beneficiaries.

Accordingly, seal-salmon interactions are conflicted by multiple, opposing interests, rooted in economics, tradition, conservation and welfare concerns alike. Whilst an outright ban on lethal seal control may be desirable by many, in terms of management this would likely alienate fisheries stakeholders and simply exacerbate the conflict as seen in similar terrestrial systems (*e.g.* Young *et al.*, 2005; Thirgood & Redpath, 2008). But will the killing of certain individuals *really* achieve measurable reductions in depredation and increased catches of fish? Not according to the science it seems. So then, is it acceptable for management to allow stakeholders to kill a few predators simply to lower the temperature of the conflict?



2—THE APPLIANCE OF SCIENCE

The Moray Firth Seal Management Plan was the first attempt in Scotland based on current scientific knowledge to explore alternative strategies to the traditional ‘either-or’ approach of managing seals and salmon through the development and testing of technical innovations to potentially achieve a ‘win-win’ outcome (Butler *et al.*, 2008). Agreed "management areas" were delineated within and around river mouths, where any seals present in these areas would most likely be preying on salmon and could thus be qualified as ‘rogue’ individuals—the targeted shooting of which, at appropriate times of the year, would aim to protect more vulnerable salmon stocks.

Graham *et al.* (2011a) subsequently qualified the existence of ‘rogue’ seals, concluding that the specific targeting of repeatedly-identified nuisance individuals in rivers would be more likely to remove those animals consuming salmon, resulting in a larger per seal benefit to salmon compared to indiscriminate shooting practices. However, the whole concept of rogue seals is currently somewhat of a charade within the industry, as in the absence of repeated and skilled photo-identification to isolate problematic individuals many innocent seals continue to be shot, thereby emphasising the futility of this endorsement (Wilson & Pereira, 2009). Even if a problematic seal is removed from a fishery, experience shows it will be replaced by another (Wilson & Pereira, 2009)—as these predators are naturally attracted to any structure providing shelter for prey (including the hulls of ships) and are invariably drawn to coastal installations by the numerous schooling fish taking refuge between the set-nets / sea cages and the shore. Indeed, this might explain why the large majority of ‘rogue’ seals recovered for necropsy are seen to have no or little salmon remains in their stomachs (Andrew Brownlow, Scottish Marine Animal Stranding Scheme).

Within the present management process, further scientific objectives aim to develop alternative, non-lethal measures in place of shooting for keeping seals away from fisheries. Recent advances in the application of acoustic deterrent devices (ADDs) have been a major progression in this direction (*e.g.* Harris *et al.*, 2014), except the cost-effectiveness and operation of these devices remains a major issue at this time and further technical development is essential before their wide-scale use becomes a realistic option. There is also still considerable variation in the perceived levels of effectiveness of ADDs for seals at present (Quick *et al.*, 2004; Graham *et al.*, 2009), as animals may become habituated to the sounds which could even serve to attract them, communicating a "dinner-bell" effect (*e.g.* Königson, 2007). According to Westerberg *et al.* (2007), some animals have learned to use the pauses between pulse transmissions to make rapid raids on gear, whereas others may be deaf or insensitive to the sound pulses produced (Harris *et al.*, 2014). A further problem is that ADDs are normally introduced after animals have already located an installation and thus have a driving motivation to overcome the discomfort of the sounds produced in view of the perceived rewards (Westerberg *et al.*, 2007). Harris *et al.* (2014) have noted that grey seals are far more persistent than common seals in this regard.

On another note, the impact of ADDs upon other marine mammals in the marine environment—particularly cetaceans, due to their inherent sensitivity to the high frequencies used by these devices—is increasingly viewed with concern (*e.g.* Northridge *et al.*, 2010). During ADD trials at a costal bag-net site in the outer Moray Firth during 2012 and 2013, researchers undertaking long-term studies of the bottlenose dolphins in this region observed direct avoidance of the test area (by a distance of approximately 8 kilometres) when the devices were operating (Cetacean Research & Rescue Unit, unpublished data), clearly corroborating these concerns.



*‘Grey seals
may be more
persistent than
common seals
when it comes
to interactions
with salmon
fisheries’*

The installation of anti-predator nets by fish farms seems to be a realistic option for reducing attacks upon pens (Wilson & Pereira, 2009). Nonetheless, these nets must be high-tensioned and well-maintained to remain effective and of a specified mesh size to prevent the entanglement and drowning of wildlife. At coastal netting stations in the Baltic Sea, large mesh salmon traps and pontoon (seal-safe) trap nets have been shown to be effective in reducing depredation by seals (Lunneryd *et al.*, 2003; Hemmingsson *et al.*, 2008), but these have yet to be trialled in Scotland as indiscriminate shooting practices continue. Evidently, a strategy aiming to deprive seals of reward, making nets less interesting to the animals by design, will have the best, long-term mitigation effect (Lunneryd *et al.*, 2003). In addition to modifications to nets, the use of electrical currents could be employed to deter the predators from touching fishing nets and cages, and preliminary trials have shown that both grey and common seals are indeed responsive to low voltage pulses (Milne *et al.*, 2012). In terms of fish farms, however, close-containment farming (*e.g.* Ayer & Tyedmers, 2009) would eliminate the problem of wildlife conflict altogether, as well as reducing proximate environmental impacts (Merceren *et al.*, 2002; Naylor *et al.*, 2005). Those trials that involve

interested stakeholders from the outset are evidently going to be most successful, although there is some evidence for the effectiveness of local mitigation techniques, such as scaring or chasing seals away from fish farms with boats.

Determinations by scientists of the permitted number of seals culled in Scottish waters each year are calculated from seal censuses and the Potential Biological Removal (PBR) technique (Wade, 1998) which determines the number of individual seals that can be removed from local populations without causing population declines. From regional PBR calculations, a maximum of 1,039 seals were granted to licensees in 2013—774 greys (approximately 0.7% of the population) and 265 commons (slightly less than 1% of the population)—a reduction of 12% in grey and 9% in common seal quotas granted in 2012, and a 25% and 16% respective reduction since the system was first introduced in January 2011, with further cuts again in 2014 (Figure 2).

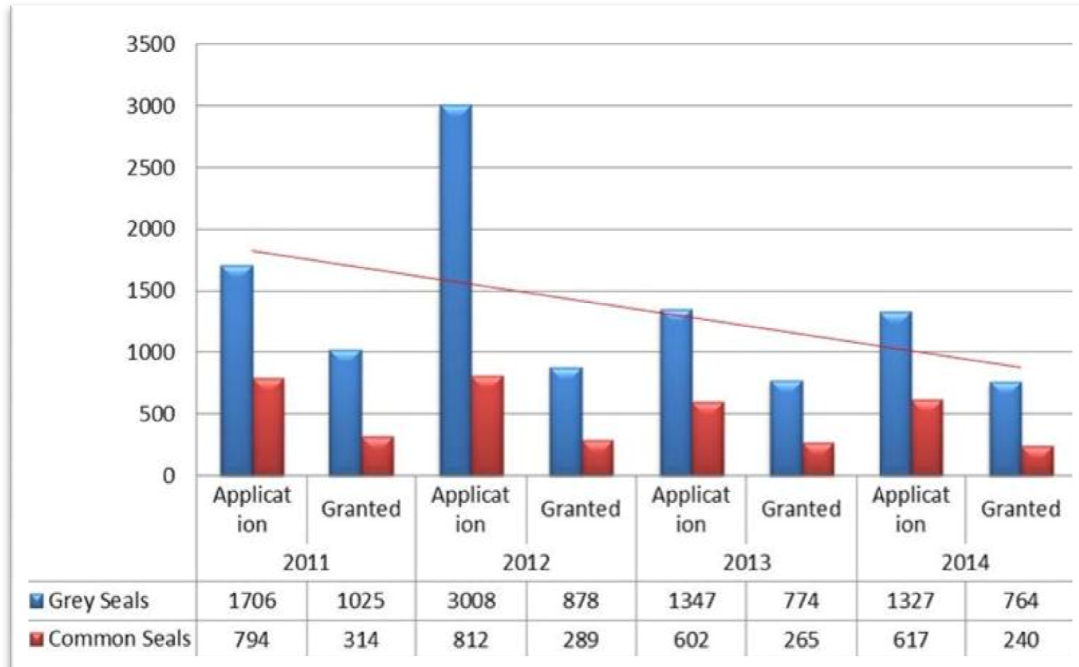


Fig. 2. Showing the number of seals requested by licence applicants against the actual numbers granted by Marine Scotland between 2011 and 2014 (Source: <http://www.scotland.gov.uk/>).

Whilst it is widely recognised that PBR may not be the best method for managing seal populations in Scotland ([SCOS, 2012](#)), since information necessary for assessing carrying capacity or determining appropriate alternative management targets is not currently available, a conservative version of PBR for managing anthropogenic impacts remains in place. However, population declines are clearly evident for common seals in many parts of Scotland, and simple modelling suggests they will effectively disappear within the next 20 years. Therefore, how can the regional killing of these animals under PBR be acceptable at this time?



*‘Major declines
have been
documented in
common seal
populations in
parts of
Scotland giving
clear cause for
concern’*



3—A LICENCE TO KILL

The Marine (Scotland) Act 2010 requires all licensees to provide a quarterly report of the numbers of seals shot each year and, wherever possible, for kills to be recovered for necropsy. This information (from reports and *post-mortem* examinations) is subsequently reviewed, whereupon any concerns can be pursued with the licensee(s) thereafter. Marine Scotland has the ability to vary or revoke licences at any time it considers necessary and penalties may be imposed. So far, so good it would seem. However, since it is an offence to exceed the allocated number of kills, it is not necessarily in the best interest of licensees to accurately report their kills—especially when permitted quotas are close to exhaustion, since nobody is monitoring their activities anyway. Many non-profit welfare organisations (NGOs) have registered this concern with Marine Scotland, as they continue to accumulate evidence for illegal shooting and other misconduct within the industry. For example, numbers submitted by the Scottish Wild Salmon Company (Usan Salmon Fisheries Ltd) to Marine Scotland for the second quarter of 2012, reported 19 grey seal kills from their coastal netting operation in the Moray Firth (published data at <http://www.scotland.gov.uk/Topics/marine/Licensing/SealLicensing>). However, 24 kills were documented and photographed by local NGOs in this period, plus additional seals were also shot by the fishery that were washed offshore. In addition, shooting was conducted less than 50 metres away from a residential area (in plain sight of residents and visiting tourists), yet very little or no effort was made by the fishery to recover the dispatched carcasses from the foreshore. When confronted by residents about this apparent apathy, employees of the fishery responded in a dismissive and even threatening manner, and yet no direct action was taken by Marine Scotland in response to the numerous complaints received. In a letter dated 28 June 2012 responding to the Crovie Preservation Society, Marine Scotland stated: "We have found

nothing to date to suggest that the fishery (Usan) have breached the terms of their licence". On 31 March 2013, the very same fishery illegally shot and killed a seal before their licence was even operational (Figure 3), but still no penalties were imposed. Contrary to these being isolated cases, such illicit activities are evidently widespread, as the unlawful and indiscriminate killing of Scottish seals continues each year.



Fig. 3. Adult grey shot by the Usan Fisheries in Crovie before the fishery had even opened in 2013.

Reports of multiple killings being recorded as “one” may also be commonplace within the industry. In addition, there are currently no reported figures for seals that are mortally wounded by marksmen (*i.e.* individuals that are struck and lost), since only clean kills are reported or recovered for necropsy by fisheries to date. Indeed, no respecting marksman would want to return exhibits of poor marksmanship, and yet the conditions in which shooting typically takes place are rarely ideal

(i.e. from unstable vessels or in inclement sea conditions), and therefore misses or near misses will certainly occur—thus shooting seals in the water is a practice that several veterinary panels have judged unacceptable for this reason. Published figures from the Canadian seal hunt reveal that ‘struck and loss’ numbers may account for 20 to 50% of all clean kills reported (Sjare & Stenson, 1999), thus the current system of self-regulation by fisheries in Scotland is clearly inadequate in this respect. Evidently, many kills go unrecorded by marksman—some sink and others may get washed out to sea—but there is also accumulating evidence of unlawful shooting from moving vessels, routine sinking and/or dumping of undocumented animals at sea. Whilst officials in offices may fail to see what actually transpires at sea level, it seems that in some cases even local managers are not fully aware of what truly goes on at their own sites.

Undoubtedly the number of seals being killed at present is proportionally lower than historic levels, but in view of the extent of unreported killings, annual numbers are still believed to be in the thousands in contrast to published Government's figures from fisheries themselves. In terms of legitimate management, selective control is certainly preferable to widespread population reduction (from both an ecological and a welfare perspective). However, recurrent shooting at the same nominated sites will undoubtedly be detrimental to "local" populations which remains a further concern.

The current definition of problem or ‘rogue’ seals in management guidelines as "any individual in a certain area", is certainly highly controversial, as mentioned earlier, resulting in the death of numerous, innocent animals each year. None of the grey seals recovered for necropsy from the Moray Firth Usan fishery site in 2012 for example, had any trace of salmon in their stomachs, whilst witnessed shooting was clearly indiscriminate and even brutal. Individuals simply passing by the set-

nets were systematically killed by the marksman. In addition, the large majority of seals shot by the fishery in 2012 and 2013 were evidently pregnant females, accounting for two lives instead of one.



*'2 for 1!
For every
pregnant or
nursing seal
shot, two lives
are taken rather
than one'*

In conflict situations where livelihoods are at stake, beneficiaries will inevitably breach wildlife protection laws in the interest of their financial profits. This is not only an issue in Scotland of course, but a worldwide problem (*e.g.* Woodroffe *et al.*, 2005; Milner & Redpath, 2013) and one that is difficult to tackle in a self-regulating industry where formal monitoring by a licensing body is highly impractical.



Justification by fisheries for the non-use of nonlethal methods for reducing depredation predictably comes down to expenditure—as equipment, staff costs and training all negatively impact upon gross company profits. However, lessons learned from other countries demonstrate that modifications to both cages and nets *can* result in permanent reductions in seal attacks (*e.g.* Sepúlveda & Oliva, 2005) and hence the current lack of these nets in Scottish fisheries—due to a general reluctance of many stakeholders to adapt nets and/or fishing practices for fear of reducing catches—needs to be addressed within the present management system. Gear development is of course a long-term process, but until such time that modifications to coastal bag-nets have been carried-out, no seal can be forgivably shot "as a last resort" by coastal operations under the present guidelines.

The *Scottish Seal Management Code of Practice* clearly states that seals should only be shot "where this is necessary to prevent serious damage to a fishery" and "in suitable weather conditions when there is sufficient visibility and sea conditions are such as to allow a clear shot". Shooting from moving vessels (an unstable platform) is definitely out of the question, and animals should only "ideally be shot when people are absent and when there is a good chance of recovering the carcass". Accordingly, no shooting should be conducted (i) in sea or weather conditions that would hamper a direct and/or immediate kill, (ii) from boats, or (iii) in view of the general public. Concerted efforts to recover all carcasses for *post-mortem* analysis should also be made.

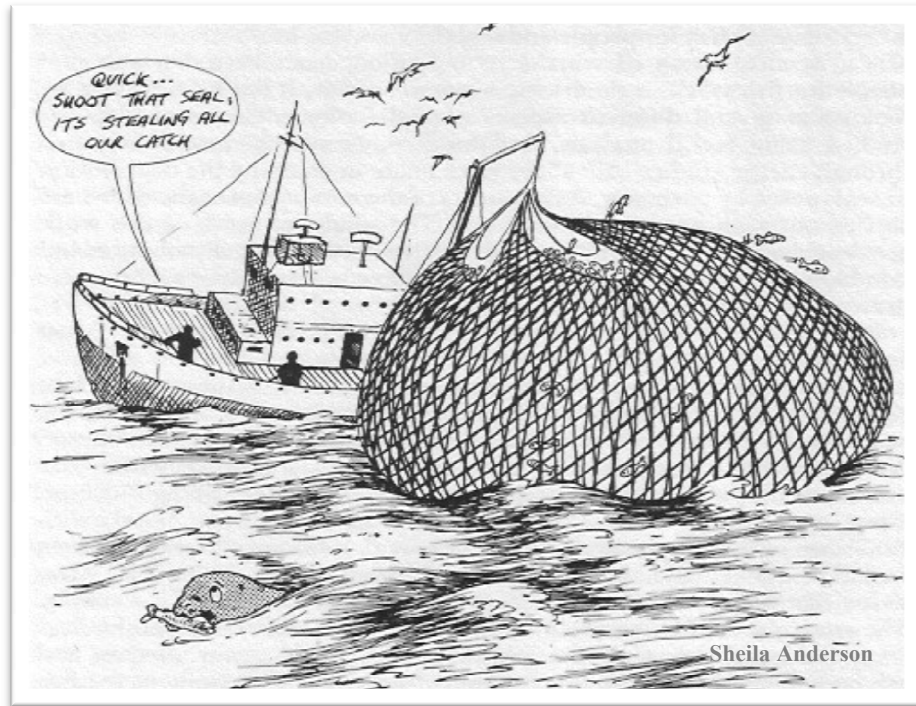
Regulations for shooting distances from nets should also be addressed. The *Code of Practice* currently states that, as a licence condition, "seals must be shot (as a last resort) from a range of no

more than 150 metres" and "within areas specified in the licence". However, unlawful and indiscriminate shooting has collectively been witnessed at haul-out sites, in pupping areas and of travelling animals simply passing by coastal installations, often far outwith this permitted range and even several kilometres away from the site (SSPCA Special Investigations Unit). Such behaviour within the industry is presently inexcusable and difficult to justify when there is still little understanding of the measurable impact of depredation by seals on salmon stocks. Current evidence suggests that the predation of salmon by grey seals is extremely low (Hammond *et al.*, 1994) and on size-classes below minimum landing sizes (Cronin *et al.*, 2014). Furthermore, modelling studies predict that if every grey seal in UK waters was removed, any possible 'surplus' of fish liberated to the fishing industry would be negligible (Middlemas *et al.*, 2003; Hammond & Grelier, 2006)—and at worst might even result in a further reduction in available salmon due to increased multispecies interactions (Engelhard *et al.*, 2014). Conversely, however, predation by common seals may be less trivial in some parts of their range (*e.g.* Sharples *et al.*, 2009) which may be significant in their management.

Inevitably, the setting of nets near haul-out sites, on established travel routes or adjacent to foraging grounds will cause operational problems, and this should be overseen to ensure those main areas of seal activity are avoided in order to minimise interactions. The relocation of set-nets and even abandonment of areas experiencing high seal depredation (as in the Moray Firth), should further be enforced as an alternative solution to mass shooting. Therein, a detailed review of the international control measures used for seals—along with case studies validating their effectiveness—is urgently needed at this time.

Undoubtedly a greater understanding of the foraging behaviour of these predators will be helpful in mitigating the anticipated impact of depredation upon fisheries, but only when we can

accurately determine the effect that populations are actually having upon fish stocks and the potential effect that removing these mammals may have should we even begin to contemplate lethal control. In the meantime, good practice must be maintained over gross profits which may dictate government subsidies to facilitate the necessary modifications to current fishing methods required.





5—AN ISSUE OF TOLERANCE

It is felt very strongly by salmon fisheries that the impacts of seals, particularly in terms of direct interactions, have greatly increased in recent years, but this is difficult to justify when we have no real understanding of what the competition is. Studies have indicated that shooting seals in estuaries provides little or no benefit to fisheries, as these seals do not feed exclusively on salmon and they consume far fewer fish than are caught by anglers each year. Seals have also been exonerated of much scar damage to fish (*e.g.* Thompson & Mackay, 1999), and animals shot near nets will quickly be replaced by others. The species assembling in river estuaries are also typically common seals, the shooting of which could critically endanger local populations that are already in decline.

The search for non-lethal and environmentally friendly predator control methods consequently requires cooperation, trust and transparency between the fisheries, scientists and animal protection interests. In terms of management, existing laws and regulations need to be strengthened, to ensure mitigation measures are fully and effectively taken up and licensees are held accountable for negligent and/or unlawful activities. Revoking of licences needs to be a realistic reprimand, and operators who continue to breach these regulations should conceivably be shut-down.

Fisheries stakeholders need to remain tolerant as they work with scientists to develop a more sustainable industry that can co-exist with natural populations of seals and other marine mammals. Close-containment fish farms, for example, would be a far better option than net-pens in this respect, whereas ecologically-unsound and unsustainable bag-net fisheries should almost certainly be bought-out and consigned to the Dark Ages. Indeed, with creative thinking and cooperation it should be

possible to create a new, eco-friendly industry worthy of this millennium which will place seal-fisheries conflict in the past.

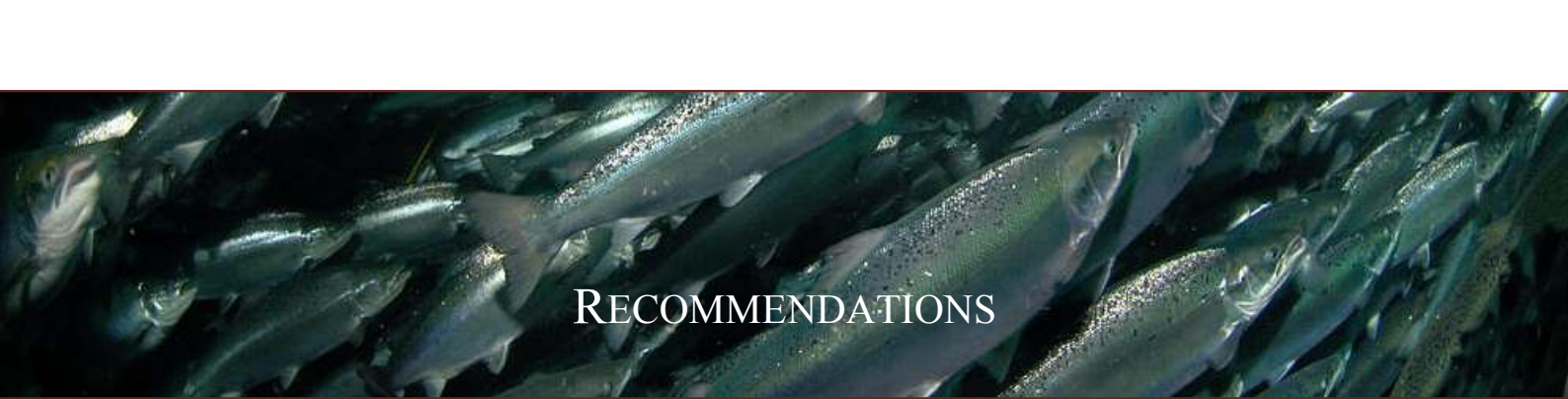


*‘ The search for
alternative, non-
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Accordingly, the management process must address those social factors which shed light on the less tangible and perception-based elements of this conflict, to seek shared solutions within the current legislative framework. Effective management will require building appropriate processes that consider stakeholder positions, assess the evidence, aid negotiation and further explore alternative mitigation options. Conflict management is most likely to succeed by continuing to build trust, linking science and local knowledge, and building partnerships (Dickman, 2010). However, membership of management groups needs to be balanced to involve *all* parties with an interest in this issue, including animal welfare and non-profit representatives (who have previously been excluded and even refused from management committees). The current bias towards commercial interests in existing seal-fisheries management groups is not acceptable—as “hand-picked” members from the

commercial sector currently get to decide who they see fit to join these groups—and clearly needs correcting.

The media also presents a challenge, and perhaps an opportunity, in this conflict. In the worst case, they can highlight the conflict aspects and sensationalise them rather than educate. Building good relationships with the media and supporting constructive journalism are therefore important components of the management process. Similarly, building education programmes that support the process will aid more rapid progress and build a better understanding as to why certain decisions are made.



RECOMMENDATIONS

(i) Fish farms

There is a general consensus, even by many fish farmers, that there is no need to shoot seals as a method of controlling attacks when so many alternative, non-lethal methods are now readily available to the industry. Where seals are difficult to deter from farms however, those strategies that ultimately deprive these animals of reward and make the site less interesting to them will inevitably have the best, long-term mitigation effect. Ultimately, closed-containment farming would be the most effective solution to this conflict, as this method would eliminate the problem of seal-salmon interactions altogether, as well as reducing local environmental impacts.

(ii) Netting Stations

There are currently few coastal netting stations remaining in Scotland. Most have already been bought-out by fisheries trusts, as this fishing method is hugely unpopular with river authorities, landowners and sports fishermen/anglers alike, in addition to its impact upon other marine wildlife through bycatch, entanglement and direct culling. Continued shooting by netsmen may be highly detrimental to local (and even endangered) seal populations, whilst the use of acoustic deterrents in coastal installations may be largely ineffective for seals but detrimental to other marine animals such as cetaceans. In fisheries experiencing high depredation by seals, the relocation of nets and/or abandonment of these areas needs to be overseen as an appropriate legislative response in preference to the wide-scale indiscriminate shooting that presently occurs. Coastal netting stations are arguably non-sustainable, disruptive (even fatal) to wildlife, disagreeable to anglers and river authorities, and

impossible to regulate at this time. The remaining fisheries should subsequently be bought-out or even paid off by the government and respectfully consigned to the past.

(iii) Anglers & Fisheries Trusts

Anglers and fisheries trusts should also have no real requirement for shooting seals in rivers. Seals and salmon have coexisted since they started swimming, and it is only the intervention of man that has resulted in the present conflict. Acoustic devices have proved effective in reducing the presence of seals high up in river systems, and it is debatable that the occasional presence of one or two seals high up in rivers will have any measurable effect upon salmon numbers in contrast to catches by anglers. According to Graham *et al.* (2014a), only a small number of individuals of both seal species use rivers anyway, whilst telemetry data confirms that individuals using rivers also use offshore foraging areas as well—which probably accounts for the fact that salmon comprise just a small percentage of the diet of these sea mammals—and so live and let live.



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Appendix A. Summary of the mitigation measures used in conflicts with seals and salmon in (a) rivers and inland fisheries, and (b) fish farms, showing the perceived effectiveness of each method and its limitations. Reproduced from Milner & Redpath (2013).

Measure	Use	Evidence	Mitigation success	Limitations of mitigation	References
<i>a) Rivers and inland fisheries</i>					
Lethal control of rogue individuals		U	Untested	Small proportion of seals use rivers, rouge harbour seals less easy to define	(Graham <i>et. al.</i> , 2011)
Seal removal		PRm	Effective on smaller rivers	Ineffective on rivers catching >34 fish/month	(Butler <i>et. al.</i> , 2006)
Acoustic deterrent devices		PRx, NRr	Effective in reducing seal movement upstream. Effect on catch unknown	Some devices harmful / have negative impacts on cetaceans & other wildlife. Expensive. Effectiveness depends on deployment strategy.	(Gordon and Northridge, 2002; Graham <i>et. al.</i> , 2009)
Immuno-contraception		U	Tested in Canada but not UK. New vaccines likely to be effective		(Brown <i>et. al.</i> , 1997; Scotsman, 2003)
Adaptive management	Combines monitoring, modelling & lethal control	Em1	Most stakeholders believe it is effective in reducing conflict	Some anglers & netsmen perceive problem despite evidence	(Butler <i>et. al.</i> , 2011; Butler <i>et. al.</i> , 2008); Interviews [18,23]
<i>b) Fish farms</i>					
Shooting, removal of rouge seal		NRr, Em1	Considered effective by stakeholders		(Northridge <i>et. al.</i> , 2010; Quick <i>et. al.</i> , 2004)
Acoustic deterrent devices		NRr, Em1	No consensus on overall effectiveness	Optimal deployment strategy unknown. Can exclude cetaceans from general area. May affect hearing of marine mammals. Seals may habituate.	(Gordon and Northridge, 2002; Northridge <i>et. al.</i> , 2010; Quick <i>et. al.</i> , 2004)
Netting	Wide variety of types & designs	NRr, Em1, Em2	Tensioned nets & seal blinds considered highly effective	Other types of nets widely used but only considered partially effective	(Northridge <i>et. al.</i> , 2010; Quick <i>et. al.</i> , 2004)
Stock management	Removal of dead fish, reducing stocking densities	NRr, Em1, Em2	Effective in reducing predation risk		(Northridge <i>et. al.</i> , 2010)
Translocation		PRo	Ineffective in fur seals		(Robinson <i>et. al.</i> , 2008)
Immuno-contraception		U	Tested in Canada but not UK. New vaccines likely to be effective		(Brown <i>et. al.</i> , 1997; Scotsman, 2003)

Evidence type—Scientific evidence: PRm=peer-reviewed modelling study; PRx=peer-reviewed controlled experiment; PRo= peer-reviewed observational study; NRr= Non-reviewed report, literature review, modelling study or postgraduate thesis. Empirical Evidence: Em1= Stakeholders perceptions including questionnaire results; Em2=Widely-used, best practice. No evidence: U=untested.

