CLEANER FISH WELFARE ON SCOTLAND'S SALMON FARMS

A REPORT BY ONEKIND

OneKind
Ending cruelty to Scotland's animals

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SUMMARY

Cleaner fish (lumpsuckers and wrasse species) are used by the salmon farming industry in Scotland to eat sea lice from salmon, as an alternative to chemical and mechanical treatments for sea lice. In 2016, 1.5 million farmed cleaner fish were used on salmon farms in Scotland, but this is predicted to rise to 10 million individuals used in the UK in 2020. Despite this there are numerous welfare problems that can affect cleaner fish, including: the need to provide supplementary food and shelter, negative interactions with other fish, escapes, personality variation meaning that not all "cleaner fish" will perform a cleaning role on salmon farms, health problems and high mortality rates.

OneKind believes that the use of cleaner fish should be prohibited until their welfare is safeguarded, through increased research, development of detailed welfare standards and increased collection, and publication, of data.

INTRODUCTION

In Scotland, sea lice, notably the salmon louse (Lepeophtheirus salmonis), cause severe problems for farmed salmon. Sea lice eat the skin, flesh and mucus of salmon, which can create open wounds, cause increased stress, act as vectors to allow for the introduction of diseases, and can ultimately cause mortality (Mustafa et al. 2000, Wagner et al. 2003, Thorstad and Finstad, 2018).

There are several ways that the industry attempts to treat sea lice, including chemical and mechanical treatments. There are concerns over the efficacy of chemical treatments in lieu of sea lice resistance to these, and welfare concerns over both chemical and mechanical treatments are well documented (Overton et al. 2018). As an alternative to these, cleaner fish are used to eat sea lice from salmon, with research showing that their use can significantly reduce sea lice burdens (Imsland et al. 2018).

However, the welfare of cleaner fish can often be compromised on salmon farms, The Farm Animal Welfare Committee (2014a) note that:

"The welfare of wrasse and other cleaner fish used to control sea lice on salmon is a different ethical issue from the welfare of fish being reared for food production, but no less important"

And yet, despite this, the welfare of cleaner fish is often forgotten. Data on the number used by the salmon farming industry in Scotland, and survival on salmon farms is not published; and there are large gaps in our understanding of their biology and welfare. Also, despite an increased movement towards the farming of cleaner fish, there are no detailed welfare guidelines.

This report aims to bring together the current information on cleaner fish welfare, with the hope that this will improve cleaner fish welfare on salmon farms in Scotland. The report will focus primarily on lumpsuckers (*Cyclopterus lumpus*) and ballan wrasse (*Labrus bergylta*), as these are the most common fish species used as cleaner fish in the salmon farming industry in Scotland.

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CLEANER FISH BIOLOGY AND BEHAVIOUR

The two groups of cleaner fish currently used are lumpsuckers (also known as lumpfish), and wrasse, predominantly ballan wrasse.

It is important to remember that although they are grouped together under the umbrella of "cleaner fish", species used to fulfil this role are diverse in their behaviour and biology. For example, whilst wrasse are easily stressed by practices such as handling, lumpsuckers are thought to be more resilient (European Union Reference Laboratory for Fish Diseases, 2016).

Below, some of the key characteristics of cleaner fish species are outlined. Interestingly, it is not fully known whether, or to what extent, lumpsuckers, or ballan wrasse, perform delousing behaviour of salmon or other host fish, in the wild (Brooker et al. 2018). There is some evidence that wild lumpsuckers and wrasse will occasionally consume sea lice, though this suggests that this feeding behaviour is opportunistic, and that sea-lice are not a necessary component of their diet. This is unlike tropical cleaner fish species such as the bluestreak cleaner wrasse, which are obligate cleaners, meaning that they depend almost entirely on cleaning behaviour to obtain food (Arnal et al. 2006).

Lumpsuckers, or Lumpfish

Lumpsuckers (Cyclopterus lumpus) can be found in Scotland, but are wide ranging, with populations in the North Atlantic and Arctic Ocean. Their name originates from their possession of a sucker on their underside, which is a modified pelvic fin, that they use to adhere to structures. Lumpsuckers also have an uncalcified cartilaginous skeleton, which brings them to almost neutral buoyancy (Kennedy et al. 2015).

In the wild, lumpsuckers can reach a maximum age of between 9 (males) and 14 years (females). Their behaviour in the wild has been described as semi-pelagic (or semi-demersal) meaning that they spend some of their time at the sea-floor, and some of their time in the water column (Kennedy et al. 2015). They are opportunistic feeders and will eat large planktonic organisms such as amphipods and isopods (Brooker et al. 2018).

When the breeding season occurs, lumpsuckers move from offshore waters into coastal areas. It is the males that care for and guard the eggs, with females leaving as soon as the eggs are laid (Kennedy et al. 2015). In one study on lumpsuckers in Iceland, it was found that females travelled up to 49 kilometres a day to and from coastal breeding grounds (Kennedy et al. 2015).

Like many species of fish, lumpsuckers have been shown to have unique personalities, with evidence showing that individuals can differ in their delousing ability on salmon farms and food preference, and that these differences are likely inherited (Imsland et al. 2016).

Lumpsucker istock feathercollector

Wrasse

Wrasse species used in Scottish aquaculture are thought to be ballan, corkwing, goldsinny, rock-cook and cuckoo wrasse (Marine Conservation Society, 2018). There is evidence that the wrasse family (Labridae) can perform remarkable behaviours. Several members of the Labridae family, including the blackspot tusk-fish, yellowhead wrasse, sixbar wrasse and orange-dotted tuskfish, have been observed to display tool use, using a rock to open clams, and there is promising evidence that blue-streak cleaner wrasse can recognise themselves in the mirror, which would make them only the second species of fish, after manta rays, to be found to demonstrate this ability (Bernardi 2011, Kohda et al. 2018; Ari and D'Agostino 2016).

Ballan wrasse

Ballan wrasse (Labrus bergylta) are the largest wrasse found in European waters and can be found in the North East Atlantic and in the Mediterranean. They live along rocky shores, and eat primarily decapod crustaceans and bivalves, but also algae and gastropods (Deady and Fives, 1995).

Ballan wrasse are protogynous hermaphrodites, meaning that individuals are all born female, and a certain percentage of these will turn into males, which tends to occur between 5 and 6 years of age (Grant et al. 2016). This results in a highly skewed sex-ratio, with the suggestion that only 10 % of individuals within wild populations are male (Grant et al. 2016). Ballan wrasse can live to 29 years (Devon and Severn Inshore Fisheries and Conservation Authority, 2016).

It has been shown that different morphs of ballan wrasse exist: plain coloured individuals with minimal patterning or colour, and spotted individuals that are brightly coloured and possess a spotted pattern (Villegas- Rios et al. 2013). Interestingly, these different morphs also differ in other characteristics, including growth, mortality rates and reproductive investment (Villegas- Rios et al. 2013).

Ballan wrasse istock wrangel

Cuckoo wrasse

Like ballan wrasse, cuckoo wrasse (Labrus mixtus) are widespread along the coast of Britain and prefer rocky habitats (Riley et al. 2017). They are also protogynous hermaphrodites. They eat invertebrates such as crustaceans and can reach a maximum age of 17 years (Devon and Severn Inshore Fisheries and Conservation Authority, 2016).

Corkwing wrasse

Corkwing wrasse (Symphodus melops) live in sheltered areas and prefer areas with dense seaweed (Devon and Severn Inshore Fisheries and Conservation Authority, 2016). They can live up to 9 years. Interestingly, some corkwing males look to gain access to mating opportunities. These so called "sneaker males" resemble females in order to "trick" dominant males into letting them access females, which allows them to fertilise eggs (Uglem et al. 2001). Corkwing wrasse have been observed performing cleaning behaviour in aquaria (Potts 1973).

Goldsinny wrasse

Goldsinny wrasse (Ctenolabrus rupestris) have a lifespan of 14 years for males, and 20 years for females (Sayer et al. 1995). They feed on small invertebrates, crustaceans and molluscs, and can be found in shallow waters in the summer but move to deeper waters in the winter (Devon and Severn Inshore Fisheries and Conservation Authority, 2016, 2016, Sayer et al. 1994). Male goldsinny wrasse hold territories and can be very aggressive towards other males that enter their territory (Hillden, 1981). Cleaning behaviour by this species of wrasse has been observed in the wild, with observations of some goldsinny wrasse cleaning ballan wrasse along the Swedish west-coast (Hillden, 1983).

Rock cook wrasse

Rock cook (Centrolabrus exoletus) are the least studied species of British wrasse (Devon and Severn Inshore Fisheries and Conservation Authority, 2016). They are found amongst rocky reefs, seaweed and seagrass (Devon and Severn Inshore Fisheries and Conservation Authority, 2016). A study by Sayer et al. (1996) looked at the diet of rock cook in Scotland, and found that males ate predominantly mussels, small crustaceans and polychaete worms, and females ate gastropods, mussels and small crustaceans. They reach a maximum age of 9.

Ballan wrasse Jonmp English Wikipedia

HISTORY OF CLEANER FISH, SIZE OF THE CLEANER FISH INDUSTRY AND FUTURE PLANS

The use of wrasse as cleaner fish in Scotland on salmon farms began in the late 1980s and early 1990s. Their use then petered out due to developments in chemicals used to treat sea lice. The interest in wrasse as a cleaner fish re-emerged in 2010 following emerging resistance of sea lice to chemical treatments, as well as public concern over the use of chemicals in the production of salmon (Imsland et al. 2015). Since then, the use of wrasse has grown, for example the fishery for wrasse increased by nearly 400 % between 2013 and 2014 (Marine Conservation Society, 2018).

Lumpsuckers are newer additions to the role of cleaner fish on salmon farms. The first commercial trials to produce lumpsuckers began in 2011 (Powell et al. 2018). Lumpsuckers are used as an alternative to ballan wrasse which take longer to reach an appropriate size for use in salmon pens and which are ineffective at eating sea lice in colder temperatures. Indeed, it has been shown that ballan wrasse stop feeding at 6˚c and enter torpor, but lumpsuckers can continue feeding until 4˚c.

The use of cleaner fish in aquaculture both globally, and specifically in Scotland, is expected to grow rapidly. In 2016, 1.5 million cleaner fish were used by the Scottish industry, but by 2020 it is expected that 10 million cleaner fish will be required in the UK, the majority of which are likely to be lumpsuckers (Marine Conservation Society, 2018)."

Indeed, there is growing movement away from wild-caught wrasse to farm-raised lumpsuckers (Environment, Climate Change and Land Reform Committee, 2018).

Wrasse

Wild-caught wrasse

The Scottish Salmon Producer's Organisation (SSPO) which represents salmon farming in Scotland, states that approximately half of wrasse used on Scotland's salmon farms are wild caught, and the other half are farmed (SSPO, 2017). It is thought that up to a million wrasse each year are caught for the salmon farming industry in Scotland (Marine Conservation Society, 2018). Wild wrasse are caught off the coast of Scotland, but because of demand outstripping supply, wrasse are also caught off the coast of England, with an estimated 1 million wrasse (thought predominantly to be ballan wrasse) being harvested from this region each year (Faust et al. 2018).

The UK wrasse fishery is largely undocumented, and landings of wrasse are rarely species-specific. For example, from Marine Management Organisation fisheries data in 2016, there were 341 landings of wrasse, with 340 of these being categorised as "wrasses", with only one wrasse landing recorded to species level- in this case as "ballan wrasse". In 2017, 39 tonnes of "wrasses" were landed into Scotland (Marine Scotland, 2018). Riley et al. (2017) also note that wrasse may also be categorised as "other demersal fish", making understanding the true scale of the UK wrasse fishery difficult.

The unregulated nature of the UK wrasse fisheries, coupled with several characteristics of wrasse (including their limited home range, long life-span, reproductive ratio and temperature-related behaviours) makes wrasse vulnerable to exploitation, which means that consequences of fisheries for wrasse may be large (Marine Conservation Society, 2018).

Wrasse are caught predominantly using traps (creels or pots), but other methods such as gillnets are sometimes used, and in Scotland the use of fyke nets (long nets held open by hoops) to capture wrasse has increased rapidly (Riley et al. 2017). If wrasse are not the correct size to be harvested (minimum size 12cm, maximum size 17cm (goldsinny, rock-cook and corkwing) or 24cm (ballan and cuckoo wrasse)), they are then released back. However, once they are released wrasse can also encounter further problems. This is because capture can cause problems with their swim bladder, which will then impact on their ability to control their buoyancy. This means that, if they are released soon after they are caught, wrasse will often remain at the surface, which leaves them vulnerable to predation by birds (Devon and Severn Inshore Fisheries and Conservation Authority, 2017).

If caught in England, wild-caught wrasse are then stored in a cage or barrel at the harbour (Devon and Severn Inshore Fisheries and Conservation Authority, 2017). They may then be sent to a facility that will store them before transport to Scotland. In England, there are 54 facilities that are authorised to store wrasse, all of which are in Cornwall, Devon or Dorset.

Wrasse are then transported to salmon farms. One example of this is documented in a report by Devon and Severn Inshore Fisheries and Conservation Authority (2017) who describe a journey where wrasse were transported from Plymouth to Scotland on tanks on either the back of a pick-up truck or in an attached trailer. There is a suggestion that mortality rates during transportation can be high (Marinet, 2017).

Farmed wrasse

In 2017, 3 companies on 3 sites produced 58,000 wrasse. This was a big decline in production compared to 2016, when 118,000 wrasse were produced (Figure 1). The sites that produced wrasse were Evanachan Salt Water (operated by Otter Ferry Seafish), Evanachan Marine Hatchery (Otter Ferry Seafish) and the Larval Rearing Unit (Marine Harvest).

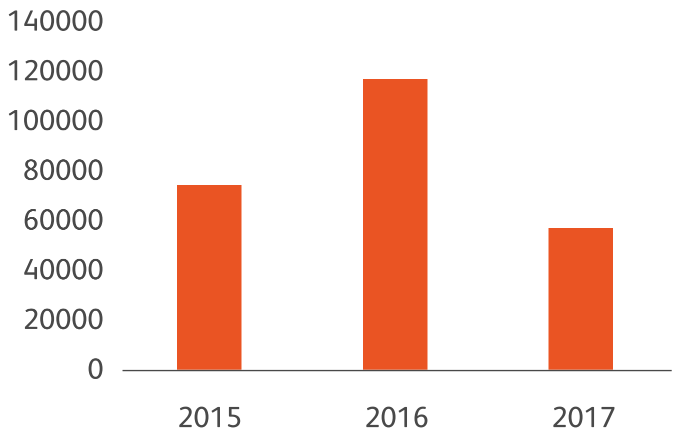


Figure 1. The number of wrasse produced for use by the salmon farm industry in Scotland.

Source: Marine Scotland Fish Farm Survey 2017.

Farming ballan wrasse is new, with the first farmed ballan wrasse being deployed in Scotland in 2013. Farming wrasse has its challenges, for example the fact that they are protogynous hermaphrodites can cause challenges in broodstock management (Brooker et al. 2018). Furthermore, because of the long time it takes for ballan wrasse individuals to reach sexual maturity (6 years for females, 12 years for males), there is still reliance on wild-caught broodstock, which is not sustainable (Brooker et al. 2018).

It takes 18 months for ballan wrasse to reach the correct size for deployment (Brooker et al. 2018). Once deployed, it has been shown that farmed ballan wrasse are equal to wild-caught ballan wrasse in their delousing ability (Skiftesvik et al. 2013).

Lumpsuckers

Wild-caught lumpsuckers

Because they are easier and quicker to raise in hatcheries, all lumpfish deployed on salmon farms in Scotland are from a farmed origin (SSPO, 2016). However, the salmon farming industry still relies on the capture of wild lumpsuckers for broodstock (Powell et al. 2018).

Therefore, the wild-catching of lumpsuckers is not common, for example only around 300 adult lumpsuckers were taken from UK fisheries in 2014 (Powell et al. 2018). In 2017 only 31 kilograms of lumpsuckers were landed into Scotland (Marine Scotland, 2018).

Farmed lumpsuckers

The first pilot trials for the commercial production of lumpsuckers began in 2011 (Powell et al. 2018). In 2017, 925,000 lumpsuckers were produced for use on salmon farms in Scotland. This is an increase by 300 % on 2016, when 262,000 lumpsucker were produced (Marine Scotland, 2018; Figure 2).

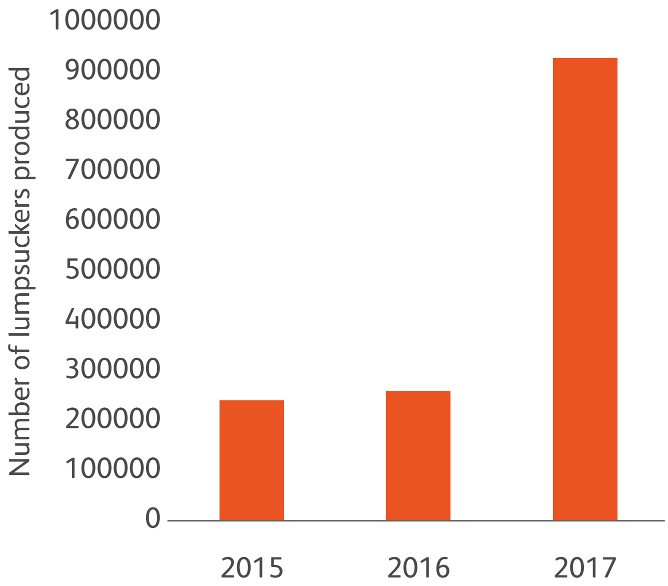


Figure 2. The number of lumpsuckers produced for use on salmon farms between 2015 and 2017.

Source: Marine Scotland Fish Farm Survey 2017.

Seven sites in Scotland produce lumpsuckers for use on salmon farms. They are: Evanachan Salt Water (operated by Otter Ferry Seafish Ltd.), Evanachan Marine Hatchery (Otter Ferry Seafish Ltd.), Marine Farming Unit (operated by FAI Aquaculture Ltd), FAI Aultbea (FAI Aquaculture Ltd), Marine Hatchery (Grieg Seafood Shetland Ltd.), FAI Shetland (FAI Aquaculture), and Laxford Hatchery (Loch Duart Ltd).

Broodstock (parent fish) used to produce farmed lumpsuckers are still wild-caught (Powell et al. 2018). Broodstock are killed in order for gametes to be obtained for artificial fertilisation (Brooker et al. 2018). Whilst it is possible for lumpsuckers to spawn naturally in captivity, this produces eggs that are less successful, therefore artificial fertilisation is favoured (Brooker et al. 2018). Eggs then hatch to become larvae, which then grow to become juvenile fish.

Lumpsuckers grow fast, and it takes between four and seven months for lumpsuckers to reach “production size”, of 20cm for males and 32cm for females, at which point they are ready to be deployed onto salmon farms (Powell et al. 2018).

In 2017, the vast majority (85 %) of lumpsuckers deployed on salmon farms in Scotland originate from eggs sourced from Norway and Iceland, with none coming from local sources (Whittaker et al. 2018). However, recent evidence shows that lumpfish have genetically distinct groups across their range, and that those found in Scotland are distinct to those found in Iceland, and parts of Norway. This suggests that lumpsuckers from Norway and Iceland may not be well-suited to use of Scottish salmon farms (Whittaker et al. 2018).

Lumpsucker Fish Health Inspectorate

Various reviews or reports have identified welfare issues that can affect cleaner fish on salmon farms. Treasurer and Feledi (2014) note that the welfare issues that wrasse may face on salmon farms include the need for shelter, lack of supplementary food when lice numbers are low, and handling. The Farm Animal Welfare Committee (2014a) also note that welfare issues associated with the use of cleaner fish include capture from the wild, predation by salmon, and the lack of shelters. Finally, the Fish Health Inspectorate, which inspects the health of fish on salmon farms, describes problems including swim bladder problems for wrasse; disease problems; and inadequate provision of supplementary food.

Need for supplementary food

The provision of supplementary food is vital to maintain the welfare of not only cleaner fish, but salmon as well, as lack of supplementary food may cause cleaner fish to nibble at parts of the salmon, such as the fins (Skiftesvik et al. 2013).

Indeed, Leclercq et al. (2015) note that:

"It is becoming increasingly evident that the supplementary feeding of cleaner fish deployed within commercial salmon pens is necessary to maintain the nutritional condition, welfare and efficacy of the biological controls".

Powell et al. (2018) also suggest that around a third of lumpsuckers die of starvation after only a few months. This highlights the need to develop adequate supplementary feeding for cleaner fish.

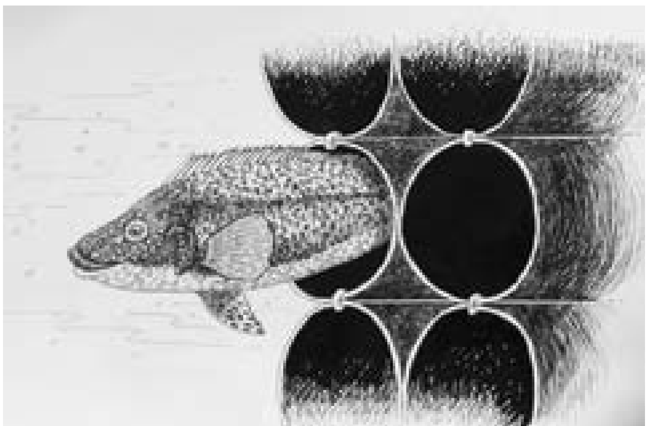
One example of this is that blue mussels have been found to be a good alternative food source for ballan wrasse, without causing a reduction in cleaning behaviour (Leclercq et al. 2013).

Need for shelter

Both ballan wrasse and lumpsuckers require shelter, to avoid aggressive interactions and predation from salmon, and for rest, especially for lumpsuckers which lack a swim bladder (Johannesen et al. 2018). In the wild, wrasse species commonly shelter in crevices over-night, and shelters or hides need to be provided to fill this role on salmon farms (Leclercq et al. 2018). The provision of shelters or substrates for wrasse reduces their stress and can ultimately lead to increased survival (Treasurer 2013).

A report by the European Union Reference Laboratory for Fish Diseases (2016) on the use of cleaner fish in aquaculture, describes the use of shelter as being essential for the reduction of stress, and predation by salmon.

The provision of shelter is vital to ensure good welfare and health of lumpsuckers (Powell et al. 2018). Imsland et al. (2015) assessed different materials for their suitability as substrates for lumpsuckers. Whilst in this study, the authors found that lumpsuckers preferred flat and smooth surfaces, they concluded that regardless of the type of substrate offered, it is crucial to the welfare of lumpsuckers that they are provided with some form of substrate so that they can rest overnight.



Ballan wrasse in a shelter Illustration: David Mitchell

Interactions with other fish

Salmon are carnivorous fish, so careful introduction of cleaner fish into sea-cages is vital. Deady et al. (1995) found that when wrasse were first introduced into cages, salmon were very aggressive towards them, with salmon injuring and/or eating the wrasse. To prevent this, it is now recommended that salmon should be satiated before cleaner fish are introduced into the cages, and that shelters should be provided to offer cleaner fish protection from salmon.

Aggression can also work the other way around, with wrasse being aggressive to salmon. If cleaner fish are not provided with sufficient food, they will pick at the eyes of salmon as an alternative food source. In one incident in Scotland in 2010, it was documented that damage to the eyes of salmon caused by ballan wrasse resulted in a number of salmon bleeding to death (Treasurer, 2013). The Fish Health Inspectorate also documented that on one visit in 2014 to the salmon farm Loch Spelve (B), there were twenty-one salmon that had eye damage from wrasse, and similarly during a visit to the salmon farm Invasion Bay, in 2018, it was noted that some salmon had eye damage caused by large ballan wrasse (Fish Health Inspectorate, 2014, 2018).

There is no evidence that lumpsuckers can be aggressive towards salmon (Imsland et al. 2016). However, it has been shown that they compete with salmon for food pellets, for example Imsland et al. (2014) found that, in a study, lumpsuckers spent 29 % of their time competing for pellets, though in this case it was not shown to have a negative impact on the growth of salmon.

Cleaner fish also show aggression to conspecifics; with cannibalism being common in the early life stages of lumpsucker (Brooker et al. 2018). Ballan wrasse can be aggressive to each other in hatcheries (Fish Health Inspectorate, 2013).

Cleaner fish individuality

Lumpsuckers have unique personalities, differing in their cleaning ability, with some lumpsuckers being observed to not eat any sea lice whilst on salmon farms (Imsland et al. 2014). Indeed, Imsland et al. (2014) found that, during their study on sea lice grazing by lumpsuckers, only 36 % of lumpsuckers actually consumed lice during the period observed. This is similar to findings by Imsland et al. (2016) who found that, when comparing the delousing ability of different families of lumpsuckers, that even within the family which showed the greatest delousing ability, only 15 % of individuals consumed sea lice during the study. This raises an ethical concern as it suggests that many lumpsuckers that are stocked on salmon farms do not perform the role of "cleaner fish".

Escapes

The website Scottish Aquaculture documents two escape events of cleaner fish:

1. Escape of 283 lumpsuckers from the salmon farm Poll na Gille on the 2nd March 2017, because of human error.
2. Escape of 493 wrasse from the salmon farm Bloody Bay on the 25th March 2017, because of predators.

Whilst this data shows that cleaner fish escapes from salmon farms are rare, escapes may nonetheless have negative impacts on wild cleaner fish populations. For example, Riley et al. (2017) note that consideration must be given to the possible impacts of escaped wrasse on local populations, such as their impact via hybridisation, or spread of diseases and pathogens. Research in Norway on cuckoo wrasse shows that hybridisation between escaped cleaner cuckoo wrasse and wild individuals can occur, though it is not clear what impact this has on the fitness of wild populations (Faust et al. 2018).

There is also evidence that lumpsuckers have distinct genetic groups across their range, with different groups found in the West Atlantic, Mid Atlantic (Iceland), East Atlantic, the English Channel, Averøy (Norway) and the Baltic Sea. Because of the genetic differences between these groups, translocation of lumpsuckers between these areas has the potential to cause genetic introgression, if lumpsuckers escape from salmon farms (Whittaker et al. 2018).

Health

Both lumpsuckers and wrasse species are prone to various diseases, including atypical furunculosis, bacterial infection, and amoebic gill disease (Fish Health Inspectorate reports, 2013-2018). Powell et al. (2018) note that fungal infection is a common disease of captive adult lumpsuckers and note that fungal infection caused up to 45 % losses in hatchery-reared broodstock over a period of two years. Secondary bacterial infections can be caused by stress, inadequate nutrition, handling during vaccination, and poor husbandry and/or water quality in the hatchery (Brooker et al. 2018).

As well as disease, research done in Norway shows that stocking wrasse on salmon farms can cause high instances of fin splitting, with severe damage especially seen on the caudal fins of wrasse (Treasurer and Feledi 2014).

There is also evidence that cleaner fish pass on diseases to farmed salmon; including the finding that lumpsuckers can possibly act as carriers of the amoeba Paramoeba perurans, which causes amoebic gill disease (Haughland et al. 2017).

Lumpsuckers can develop cataracts, which can be indicative of malnutrition, parasites, or internal imbalance such as problems with osmotic balance (Jonassen et al. 2017). In a study on lumpsuckers used in Norwegian salmon farming, Jonassen et al. (2017) found high prevalence and severity of cataracts in all twelve groups of farmed lumpsuckers surveyed. The researchers also found that, compared to wild lumpsuckers of a similar size and age, farmed lumpsuckers had a greater prevalence and severity of cataracts; leading the authors to conclude that:

"the unacceptable severe incidences observed in the present investigation raises questions concerning fish health and welfare for farmed lumpfish."

Perhaps ironically, lumpsuckers can be parasitised by the sea louse Caligus elongatus. Powell et al. (2018) note that lumpsuckers can suffer from a high prevalence and severity of sea lice. Furthermore, the Fish Health Inspectorate reported that, at the salmon farm Seaforth, in 2017, high numbers (>10) of the sea lice species Caligus elongatus were observed on lumpsuckers, which they note, may have caused lesions that were observed on the lumpsuckers. It is still not completely known to what extent sea lice have an impact on lumpsuckers (or indeed wrasse species), and therefore more research on this is needed.

Lumpsucker Scottish Salmon Watch

Brooker et al. (2018) note that the most frequent cause of disease outbreak in cleaner fish is as a result of atypical strains of Aeromonas salmonicid; which causes atypical furunculosis. This manifests itself as swellings, which may become lesions. The report on the health of cleaner fish by the European Union Reference Laboratory for Fish Diseases (2016) offers a useful source of information on some of the pathogens and diseases that can inflict cleaner fish, which are summarised in Table 1.

***Table 1.** Significant pathogens of cleaner fish; the disease they cause and, if possible, an example from Scotland. Source: European Union Reference Laboratory for Fish Diseases (2016), and the Fish Health Inspectorate (2013-2018).*

SPECIES	PATHOGEN	DISEASE	IF POSSIBLE, EXAMPLE FROM SCOTLAND
Wrasse	Atypical *Aeromonas salmonicida*	Atypical *Furunculosis*	At the Larval Rearing Unit, in 2017, increased stress led to atypical furunculosis; leading to a reduced number of wrasse transferred to salmon pens compared to the previous year.
	Vibrio anguillarum serotype O2a	Classical vibrosis	
	Paramoeba perurans	Amoebic Gill Disease (AGD)	1,407 wrasse died in one week in 2014 at the salmon farm Loch Spelve because of AGD
Both	*Tenacibaculum sp. and/or Moritella viscosa*	Sk in ulcers	
Lumpsuckers	*Atypical Aeromonas salmonicida*	Atypical furunculosis	
	Unnamed *Pasteurella sp.*	Pasteurellosis	At Evanachan Marine Hatchery, in February 2017, lumpfish broodstock were diagnosed with suspected *Pasteurella.*
	Vibrio anguillarum serotype O1	Classical vibrosis	In September 2013, the first description of classical vibrosis in lumpsuckers in Scotland was made. It documented wild-caught lumpsuckers, which suffered from "congestion and haemorrhage around the mouth, operculum, pectoral, dorsal and/or caudal fins, distended and haemorrhagic vent, fluid-filled intestine and stomach, ascites and/or exophthalmia" (Marcos-Lopez *et al.* 2013).
	Paramoeba perurans	Amoebic Gill Disease	In one visit in 2015 to the farm Cole Deep, it was noted that losses of lumpsuckers were caused by AGD.
	Vibrio ordalii	Vibriosis	
	Pseudomonas anguilliseptica	Haemorrhagic septicaemia	
	Unnamed *Flaviviridae sp*	Liver necrosis	
	Nucleospora cyclopteri	Renal granulomas	

Wrasse can also suffer because farming practices can sometimes cause them to have overinflated swim bladders, which will affect their buoyancy. Over-inflation of the swim bladder is thought to be either a response to stress, or as a result of the rapid raising of nets, meaning that the swim bladder is not able to adjust in volume (Treasurer, 2013).

Instances where being in salmon farms have caused swim bladder issues include lifting the nets for washing, or for treatment. Indeed, in their study on the welfare of wrasse in aquaculture, Treasurer et al. (2014) found that most of the mortalities during their study period were caused because of swim bladder issues.

During one incident, the lifting of nets for treatment resulted in the wrasse being unable to adjust their swim bladder, leading to over-inflation. European Union Reference Laboratory for Fish Diseases (2016) note that one of the reasons why the provision of shelters is important for wrasse is that it prevents them from sheltering among dead fish; which can cause swim bladder problems when nets are raised to remove dead fish, which can cause explosion or inflation of the swim bladder. In one incident documented by fish health inspectors at the salmon farm Vidlin North, in 2013, wrasse were observed at the surface as a result of swim bladder problems caused by the lifting of dead fish for removal (Fish Health Inspectorate, 2013).

Mortality rates

Mortality rates for cleaner fish on Scotland's salmon farms are not published by the industry, so it is not possible to ascertain the exact percentage of cleaner fish that survive the full salmon production cycle. Despite this, there is a suggestion that cleaner fish mortality can be high, with suggestion that it is near 100 %, with the European Union Reference Laboratory for Fish Disease (2016) noting that:

"Cleaner fish mortalities in salmon farms are often high, and very few cleaner fish presumably survive through a full salmon production cycle"

Furthermore, Brooker et al. (2018) note that survival of cleaner fish following deployment on salmon farms can be low. Johannesen et al. (2018) also state that, despite the assumption that lumpsuckers are hardy fish, mortality rates on farms can he high. In one incident in 2017 at the salmon farm North Shore, freshwater treatment for disease and sea lice, killed nearly 100 % of lumpsuckers on site.

Wrasse mortality rates on salmon farms can also be high, for example Skiftesvik et al. (2014) note that, in Norway, there is "considerable loss of wrasses in the salmon net pens due to predation, handling, escapes and disease." Indeed, in the same study, it was found that, for one group of wrasse caught in June, mortality 35 days post-capture had reached 75 %.

Fish Health Inspectorate reports also shed some light on mortality rates of cleaner fish, with the following instances being documented (Table 2).

Table 2. *Cleaner fish mortalities as documented by Fish Health Inspectorate reports.*

SPECIES	WHEN?	WHERE?	WHAT?
Lumpsuckers	July 2017	Seaforth	6,566 (16 %) mortality
Wrasse	July 2017	Seaforth	4,498 (12 %) mortality
Lumpsuckers	2017	Cole Deep	24,000 lumpsuckers stocked on site in Sept 2016, and now (2017) very few are left.
Lumpsuckers	April 2017	Shuna SW	High mortalities of lumpsuckers, up to 400 fish a day. Fish were treated with antibiotic for bacterial infection. No lumpsuckers left on site.
Lumpsuckers	July/August 2017	Stead of Aithness	Site stocked with lumpsuckers but these have died. This occurred shortly after the 15,000 lumpsuckers were inputted.
Cleaner fish (species not specified)	2017	Loch Alsh (Sron)	Approximately 40 % of all cleaner fish lost since input. AGD has been detected.
Lumpsuckers	Summer 2017	Raineach	Had stocked the site with lumpfish in Autumn 2015 and summer 2016, but have lost most fish.
Wrasse	December 2012	Vidlin North	Recent mortality in last weeks- 100/site/week attributed to post-treatment losses.
Wrasse	December 2012	Lismore West	Loss of 10 % of wrasse stocks since delivery in August 2012.

SLAUGHTER OF CLEANER FISH

It is essential to ensure that humane slaughter methods are in place for cleaner fish as well as for the farmed salmon". (Marine Conservation Society, 2018)

Currently, the standard method for slaughtering cleaner fish is overdosing through anaesthetic.

Skar et al. (2017) state that "an overdose of anaesthetic drugs is commonly used to kill fish, but care should be taken to maintain fish welfare", and they also note that, before anaesthetic is used, the minimum dosage and exposure times should be determined to ensure that this method is humane and reliable. This research must be species-specific, as it cannot be assumed that fish species will react the same to anaesthesia (Readman et al. 2017). For lumpsuckers, research suggests that the drugs metacaine and benzocaine can be used for small (10-20 g) fish, and medium sized fish (at 12oc), with doses of 1600 mg L-1 and 800 mg L-1 respectively (Skar et al. 2017).

Water temperature also needs to be taken into consideration, as it can alter the efficacy of anaesthesia. Indeed, it is thought that the onset of euthanasia is quicker at higher temperatures, however temperatures should not be so high that they cause stress to fish (Close et al. 1996).

LEGISLATION, REGULATION AND DATA COLLECTION

Cleaner fish are protected by the Animal Health and Welfare (Scotland) Act 2006 which places a duty of care on those responsible for the cleaner fish, to safeguard them from unnecessary suffering. This means that cleaner fish should be provided with an adequate diet, the opportunity to express normal behaviour, and protection from disease, pain and suffering.

During transport, they are also covered by the Welfare of Animals (Transport)(Scotland) Regulations 2006, which aim to safeguard the animals during transport. Under the Aquatic Animal Health (Scotland) Regulations 2009, it is an offence for those that transport aquaculture animals to fail to keep mortality records during transport. Furthermore, under the same Regulations, fish farmers must notify the competent authority or a veterinarian if there is unexplained mortality of cleaner fish.

The Fish Health Inspectorate aims to ensure the health of farmed fish in Scotland. Fish Health Inspectors are appointed by Scottish Ministers to inspect salmon farms for factors such as sea lice burdens, mortality rates of farmed fish and treatment details. As part of their inspections, they will evaluate the health of cleaner fish, identify any causes of mortality, as well as conducting diagnostic reports to identify any health issues.

There is also a lack of standards available to help safeguard cleaner fish welfare. No stand-alone standards exist for cleaner fish, though they are mentioned in standards that apply to salmon farming in Scotland, including RSPCA Assured, the Code of Good Practice for Scottish Finfish Aquaculture, and Soil Association (Table 3).

Table 3. *Cleaner fish standards.*

STANDARDS	BACKGROUND	COVERS
RSPCA Assured	Previous versions prohibited the use of cleaner fish, but the 2015 standards allowed the use of cleaner fish, with written permission. In 2018, standards were published that included more detailed cleaner fish welfare standards.	• Wild capture of cleaner fish • Handling of, and feeding of cleaner fish in pens • Cleaner fish in salmon pens • Slaughter • Wrasse hatcheries
Code of Good Practice for Scottish Finfish Aquaculture (CoGP)	The CoGP was first introduced in 2006 and covers all aquaculture in Scotland. It has been regularly updated, in keeping with changes in practice and research developments.	• Re-use of cleaner fish • Staff knowledge and training about cleaner fish • Provision of shelter and supplementary feeding
Soil Association	The organic aquaculture standards were first developed by the Soil Association in 2002. They give preference to the use of cleaner fish (or freshwater, marine water and sodium chloride solutions) for parasite treatments.	• States that the organic plan should cover how developmental, physiological and behavioural needs of cleaner fish will be met • This includes through husbandry practices, feeding, design, stocking densities and water quality

None of the standards that are used specifically for use of cleaner fish in Scotland are as detailed as those by the Norwegian Seafood Research Fund (FHF). These guidelines are detailed, species-specific and cover the whole life-cycle of lumpsuckers and ballan wrasse.

Moratorium on the use of cleaner fish

There are clear gaps in our knowledge surrounding cleaner fish welfare on salmon farms. This has led to compromised cleaner fish welfare. As stated by the Farm Animal Welfare Committee (2014a), the welfare of cleaner fish is no less important than that of farmed salmon. Thus, we believe that until their welfare can be adequately safeguarded, the use of cleaner fish by the industry should be suspended, until it can be demonstrated that lumpsuckers and wrasse used as cleaner fish on salmon farms have good lives worth living.

Increased research

There are gaps in our knowledge surrounding cleaner fish welfare on salmon farms in Scotland. These include, but are not limited to:

A. Key causes of mortality of cleaner fish on salmon farms in Scotland.

B. The best form of supplementary food and feeding mechanism.

C. Health issues, for example the impact of sea lice on cleaner fish, and the potential of disease spread between cleaner fish and salmon.

Powell et al. (2018) go into detail on gaps in knowledge in commercial production of lumpsuckers and note that things such as the number of lumpsuckers remaining in cages, risk of infection to salmon and other fish and the culling of lumpsuckers at the end of the production cycle need to be improved.

These gaps need to be urgently filled so that the welfare of cleaner fish is not compromised on salmon farms in Scotland, and that it can be demonstrably shown that cleaner fish can be provided with a good life worth living.

Development of detailed welfare standards

Whilst RSPCA Assured standards have recently been updated to include more detail on cleaner fish, there are no stand alone, species-specific welfare standards for cleaner fish used on Scottish salmon farms. It is possible to have more detailed welfare standards, for example the Norwegian Seafood Research Fund (FHF) have detailed cleaner fish guidelines that are different for wrasses and lumpsuckers, that cover:

A. Delivery and transport of wrasse

B. Overwintering of wrasse

C. Use and husbandry of wrasse

D. Catches and storage in transit of wrasse

E. Handling and transportation of lumpsuckers

F. Use and husbandry of lumpsuckers

There is urgency to develop standards that cover the whole life cycle of cleaner fish, regardless of whether these fish were farmed or wild-caught. The standards should account for species-specific differences between ballan wrasse (and, if appropriate, other wrasse species) and lumpsuckers. Furthermore, as well as stand-alone cleaner fish welfare standards, all future welfare standards that relate to farmed salmon should include detailed cleaner fish standards.

Publication of data

There are clear gaps in the collection of data on cleaner fish. Information on cleaner fish mortality rates, cause of mortalities, and numbers harvested from the wild are not adequately collected. Open Seas (2017) note that information on the number of cleaner fish used by salmon farms in Scotland and the number of wild fish used, is held by salmon farms, and is available to the Scottish Government during inspections. This information should be gathered and published by the Scottish Government. Since August 2018, the Scottish Salmon Production Organisation have started publishing mortality data of farmed salmon, and this should be extended to cleaner fish too.

Alternatives to cleaner fish

Instead of using cleaner fish, there should be an emphasis on effective, and welfare-friendly alternatives for the treatment, or prevention of, sea lice. Some promising solutions include the use of sea lice “snorkel” barriers, fallowing, and careful site-selection of salmon farms in areas that are less at-risk of sea lice infestations (Stien et al. 2016; Compassion in World Farming, 2018). Indeed, the Scottish Wildlife Trust also argue that the Scottish salmon farming industry should “invest in new technologies” as an alternative to cleaner fish (Scottish Wildlife Trust, 2018).

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