A review of factors affecting the welfare of Atlantic salmon (Salmo salar)

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Abstract

In the expanding salmon industry, many farmers use production methods that could result in poor welfare of the fish at various points of their lifecycle. We have reviewed methods used for producing salmon for food with the aim of identifying and drawing attention to factors likely to affect farmed Atlantic salmon (Salmo salar) welfare. In addition to water conditions and high stocking density at sea, other issues are important for fish welfare. Handling and transport of salmon between fresh- and seawater phases and before slaughter can have severe negative effects and research should continue to seek improved methods. Stocking densities in fresh- or seawater have substantial effects on the welfare of salmon and a reduction in densities should be considered in order to reduce fin damage in particular. Currently used feeding systems result in starvation for some fish and fin damage for others, hence new systems should be developed. Some on-demand feeding systems improve welfare. All farmed fish should be stunned prior to slaughter, not left to die of asphyxia. Carbon dioxide and electrical stunning methods do not always stun salmon humanely. The widely used methods of percussive stunning, manual or automatic, must be precise to effectively stun large numbers of fish. Welfare outcome indicators, such as fin damage, morbidity and mortality rate, should be used in standards and laws relating to salmon welfare.

Keywords: animal welfare, aquaculture, Atlantic salmon, fish farming, stocking density, welfare outcome indicators

Introduction

Aquaculture is the world’s fastest growing meat production industry globally, averaging approximately 6% annual growth from 2002 to 2012, after 10% growth for the 20 years prior to this (Food and Agriculture Organisation [FAO] 2014). The major producers of Atlantic salmon (Salmo salar) are Norway, Chile, Scotland and Canada, with the first two providing over 80% of global output (Burridge et al 2010). Most feed provided for salmon is derived from other fish, some of which could be used directly as human food and some could constitute a disease risk for the salmon, so efforts are being made to find alternative sources (Stones 2003). At present, up to 14% of salmon food can be of plant origin.

The production of salmon starts with the extraction of eggs and sperm from anaesthetised fish, followed by incubation in oxygenated freshwater, hatching, and then rearing in flowing water. Fingerlings (known as parr) are transferred to larger freshwater tanks, where they are in either flow-through tanks or a re-circulating system. Here, they remain until smoltification, a physiological adaptation from freshwater to seawater. The smolts are then either transported into large, floating cages in sheltered bays or sea lochs, where they grow for 1–2 years before slaughter or grown in enclosed large-tank systems throughout their life.

There is evidence to show that fish can show the physiological and behavioural responses that indicate fear and pain (Sneddon et al 2003; Chandroo et al 2004; Portavella et al 2004; Nordgreen et al 2007; Braithwaite 2010; Broom 2016). The cognitive ability of certain fish in some circumstances can be better than mammals, for example, as a result of their extensive experience in nature, cleaner fish can learn complex foraging tasks that some great ape species cannot (Salwiczek et al 2012). It should be noted that areas exist within the brains of fish that closely parallel those of the amygdala and hippocampus, that deal with emotion, learning and memory in mammals (Agetsuma et al 2010; Broom 2014). Scientific evidence indicates that salmon and other fish are sentient beings and surveys such as the Special Eurobarometer 442 (http://ec.europa.eu/health/survey/special-eurobarometer-442/summa.html) indicate high levels of public concern about sentient animals. There is considerable consumer concern about salmon welfare, with...