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Editorial -- Fish Behaviour and Welfare

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Fish are commercially important in both fisheries and aquaculture and their use is widespread in experimental studies. This special issue of Applied Animal Behaviour Science is dedicated to contentious topics in fish behaviour and welfare. Our use of fish as a foodstuff in fisheries and aquaculture generally involves procedures that impact upon fish wellbeing and natural behaviour. Human diets have historically included fish as an important foodstuff and the nutrients obtained from fish have been important in our neural development. We have to catch fish and we do this by hook and net on either a small scale of the individual catching few fish or on a larger scale in fisheries where thousands of fish are caught by commercial means. If we eat the caught fish, then there is a benefit to us that may outweigh the cost to the fish, however, in the recreational sport of fishing where catch and release is practiced fish are caught for the enjoyment of angling rather than for sustenance. Removing the fish from the water causes physiological stress and fish also receive hooking injuries that compromise welfare. Rather than condemning this practice, Cooke and Sneddon discuss the welfare aspects of this sport, the data on the behavioural consequences and suggestions for the improvement of techniques that may enhance the treatment of fish during angling.

Fish are farmed intensively in aquaculture which is an economic necessity to provide large quantities for the food industry yet many species' normal behaviours may be impaired by the nature of intensive aquaculture. Recommendations have suggested that for optimum welfare, animals should be able to express their natural suite of behaviours. Confining large migratory species such as salmonids to relatively small tanks or cages means they are unable to perform the extensive migrations performed by their wild counterparts so are these fish frustrated? When considering why salmonids migrate, their motivation is to find food yet if they are well fed by the farmer does this dampen the desire to migrate? The conflict of behavioural needs and the major welfare issues in aquaculture highlighted by recent scientific studies are discussed by Ashley. Species specific requirements are an important issue since fishes are one of the most diverse vertebrate taxa on the globe. Salmonids require the ability to swim constantly whereas flatfishes require ample space to rest on the substrate. When space is limited for flatfish, such as the commercially important halibut, they perform stereotypical surface swimming which has not been observed outside of the fish farm. Kristiansen and Fernö investigate individual variation in response to floating or sinking food pellets and find that stress coping style results in some individuals showing poor growth when fed floating food but their wellbeing improves when given food that sinks. These small changes in aquaculture procedures can make a real difference to fish growth and hence improve welfare and economic return.

Maintaining fish in confinement in high densities naturally leads to a high transmission of disease and parasites yet little is known about the behavioural and physiological consequences of these infections. Laboratory studies have shown tremendous changes in behaviour as a result of parasitism in fish and parasites are prevalent in aquaculture systems reducing growth and possibly wellbeing since many of

these infections cause injury. Barber discusses the impact of parasitic infection upon behaviour and suggests that their incidence may be used as a general welfare indicator in the laboratory and by the aquaculture industry.

Genetic manipulation of fish has been widespread since the mid 1980s and over 30 species of fish have subsequently been altered by genetic modification. The impacts on behaviour and welfare have become a controversial issue debated by public bodies and the media. Hallerman et al. consider the issues associated with genetic modification in fish and provide important examples of major changes in behaviour and wellbeing of fish subject to manipulation. Growth hormone transgenic salmon grow 11 times faster than unmanipulated fish leading to increased aggression but impaired swimming ability. The negative individual consequences of altering growth hormone genes also have an impact on wild populations since wild fish may be outcompeted by these transgenic individuals and this raises serious issues for the ecology and survivorship of natural ecosystems.

The use of water bodies for industry has led to considerable changes in the structure and composition of lakes and rivers. Anthropogenic activities, such as building dams or effluent run off from mines and factories, has had considerable effects upon aquatic animals that we are only now beginning to understand. Schilt details the consequences of dam building on fish behaviour demonstrating that these dams act as barriers to the natural migration of diadromous species that move between freshwater and seawater as either young going to the rich feeding grounds of the sea or as adults returning to natal rivers to reproduce. The building of dams has led to a decline in fish populations with ecosystem wide effects but improvements are being made to allow fish passage with hope for recovery of these fish species. Heavy metals from anthropogenic inputs have a profound effect upon fish since they live in such close contact with the environment. The behavioural consequences of exposure to such contaminants are detailed in Sloman's work on the natural dominance hierarchies of the highly aggressive salmonid species. These contaminants interfere with olfaction and thus disrupt dominant-subordinate relationships as well as being relatively more toxic to the lower ranking fish. These effects have serious welfare consequences in aquaculture where aggression is problematic but also has important implications for the conservation of natural populations.

Not all welfare concerns have been covered in this special issue since little work has been conducted upon large-scale marine fisheries and the pet trade but we have attempted to highlight some of the more controversial issues. Improvement of our use of fish will lead to better wellbeing and as such healthier individuals. This should be the goal of researchers since it is in our interest to conduct experiments in optimum conditions to obtain truly meaningful results. Healthier fish grow better and thus improving welfare conditions in aquaculture would be beneficial for this industry. In the natural environment, sustainability of fish populations must be achieved and it is through a better understanding of the biology of fish species that we can try to improve our treatment of fish and their habitats.