Response to the RSE in relation to its Inquiry into "Scotland's Energy Future"

Context

Consultation Question Number 8 relating to this Inquiry is concerned with: The environmental impacts of individual elements of a future energy mix, to what extent can these be mitigated, and how can any remaining waste products be dealt with?

An important aspect of offshore energy developments is their possible adverse effects upon the environment. Currently, insufficient attention is being paid by the regulatory agencies and the Scottish Government to the possible adverse effects of offshore developments upon marine animals, including mammals, birds, fishes and invertebrates.

Offshore activities which may have adverse effects upon marine organisms include: oil and gas developments (including the seismic surveys conducted to locate oil and gas deposits); offshore windfarms; and tidal energy devices, including the construction of tidal barrages.

Possible Impacts of Windfarms and other Offshore Energy Developments upon Fishes

As an example of marine animals that may be affected by offshore and coastal developments we will consider fishes. In general, Scottish marine fish stocks are in a healthy state. One exception however is the Atlantic salmon, *Salmo salar*, which is currently in a state of decline in Scotland. Another is the European eel, *Anguilla anguilla*, stock, which is in a very poor state.

In the past, Scottish rivers were renowned for their excellent salmon fishing. Those fisheries are currently in a state of decline. Overall, catches of salmon in the wider North Atlantic region have reduced in recent years. The majority of marine fisheries for salmon have now been closed to improve the state of the stocks within rivers. Salmon fisheries in Scotland are now almost entirely focused on salmon that have returned to their home rivers and the fish are caught predominantly by angling. It might have been expected that the closure of the fisheries at sea would have resulted in increases in the rod catches within the rivers. Indeed, the annual overall numbers of salmon caught by rod in Scotland did increase over the period 1952 to 2010. However, since 2010 the reported angling catch has dropped. The catch was especially low in many Scottish rivers in 2014, and has remained relatively low in 2015, 2016, and 2017. This decline in catches has also been paralleled by declining numbers of salmon counted as they enter their spawning tributaries.

The decline in salmon may be the result of a number of factors. These may include climate change within the northern oceans, and higher numbers of competing species at sea (especially herring and mackerel), which may be reducing the food available to salmon. The growth of the herring, mackerel and blue whiting fisheries may also be affecting salmon survival by taking salmon as a by-catch. There have been increases in the populations of predators that consume salmon; including birds, otters, seals and dolphins. However, it is also possible that coastal developments may be affecting the migrations of salmon through the generation of underwater noise and electromagnetic fields and increases in silt and other contaminants.

The European eel is currently regarded as a critically endangered species. It is on the IUCN Red List, and the EC Eel Regulation (EC, 2007) requires each Member State with eels to produce Eel Management Plans (EMPs) with the long-term objective of "reducing anthropogenic mortalities so as to permit with high probability the escapement to the sea of

at least 40 % of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock". There are many threats that have been suggested as causing the decline in the European eel stock: including barriers to migration; climate change and/or changes in oceanic currents; disease and parasites; over-exploitation of glass, yellow and silver eels; changing hydrology; habitat loss; pollutants; and predation. There are currently conflicting opinions as to the degree to which factors in coastal waters are contributing to the decline in eel numbers. However, eels leave rivers and travel through coastal waters on their return migrations to the Sargasso Sea to spawn, and they may be affected adversely by coastal energy developments.

Here we will consider windfarm developments, although other energy developments in the sea and in estuaries may also have adverse effects. Many windfarm developments are now taking place along the Scottish east coast and in estuaries which may be harmful to marine species, including juvenile and adult salmon migrating along the coast, outmigrating eels, and species like the cod and haddock that spawn in areas like the Moray Firth. The windfarms are likely to be operational for many decades, and therefore have the potential for affecting marine fishes and other animals for extended periods.

There have been a number of flaws in the Environmental Statements on which Ministers' approval of windfarm developments has been based. For example, in considering the impact of noise from windfarms on salmon and other fishes during the construction phase and also when the turbines are operational, it has been assumed that fishes are sensitive to sound pressure. However, it has been known for many years that salmon, eels and other fishes are sensitive to the particle motion components of underwater sounds. Another problem is that the impact assessments often do not take full account of the electromagnetic fields that may be generated by the extensive electrical cabling that runs to the shore through the area traversed by salmon, eels, and other fishes.

The construction of wind farms can involve the generation of high levels of low frequency particle motion, to which some fishes are especially sensitive. Pile driving and other construction activities may generate high levels of impulsive noise, to which fishes are known to respond. Operational wind turbines may generate seismic waves at the seabed, which may disturb benthic fishes and invertebrates. Some species, including the cod and haddock, use low frequency sounds to communicate with one another, especially during spawning. There may also be a release of silt and other contaminants during construction work, perhaps affecting the health of fishes adversely and in the case of the salmon the ability of this species to detect the scent of their home river. The multitude of cables carrying electric currents to the shore may affect the use of magnetic cues by migrating salmon and eels, which are known to use magnetic cues for orientation and navigation. The many offshore windfarms that are now planned along the Scottish coast and the changes they inflict upon the marine environment may affect fishes adversely.

Required Action

Processes for assessing the risks associated with the construction and operation of windfarms and other energy development involve a number of steps. At the start, it may be necessary to define the key species and species groupings that are likely to be affected by such developments. These may be defined in terms of those protected by legislation, but they also need to be assessed through a preliminary biological screening process (which might also then drive the species defined in legislation). In an ecological context, it is important to identify those taxa and species that may be especially vulnerable to disturbance and which also play a key role in local ecosystems. The risk to potentially sensitive species can then be properly assessed.

To assess likely impacts, scenarios are often constructed, suggesting how animals might respond to sound, and how that response might be mitigated. For example, it might be assumed that there is some movement away from the source of disturbance, disruption of migration patterns or temporary displacement from areas of known concentrations. Mitigation measures might then be proposed, such as time/area closures, or the establishment of exclusion zones. These would be intended to provide protective benefits during exposure, and might ensure that behaviour might return to normal when activity ceases. Clearly, however, to make such mitigation successful there is a need to know what actually does happen to marine organisms when they are exposed to disturbance, the duration of their responses, whether they adapt to the presence of the source of disturbance, and what the consequences of their responses are for animal populations.

So far, many of the assessments of the impacts of offshore energy developments have been poorly performed. There is an overall lack of knowledge of the effects of such developments, affecting the ability of the offshore energy industry and their regulators to properly evaluate and mitigate effects upon marine ecosystems, and making it difficult to implement informed risk-management decisions.

The Royal Society of Edinburgh could play a key role in reviewing the environmental impact assessments being prepared for offshore energy developments and recommending best practice procedures to ensure that such assessments are properly performed. It might also be possible for the RSE to identify the key gaps in our knowledge, which are holding back the development of appropriate impact assessments.