SSACN
SCOTTISH SEA ANGLING
CONSERVATION NETWORK

Offshore Renewables

Their potential impact on Scottish near-shore fish species.

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Summary

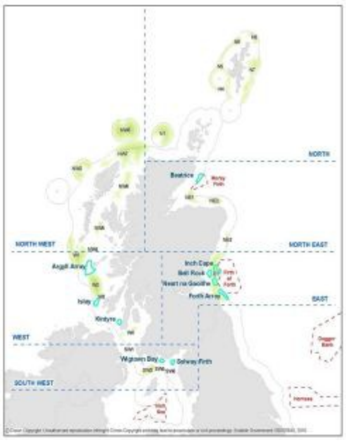
Offshore renewables are a major growth target for the Scottish Government but potentially a minefield for coastal fish stocks.

The potential impact on Scottish coastal fish stocks caused by increased noise, vibration and turbidity during the construction / operation / de-commissioning phases of offshore installations are relatively well understood the following, as a minimum, should be incorporated into any environmental assessment if it is to have any integrity:

- Disturbance/loss of spawning/nursery and overwintering grounds of demersal species
- Increased sedimentation impact on egg viability and benthic food resources
- Mortality, injury or behavioural effects on fish populations due to piling operations
- Behavioural effects on migratory movements of migratory species due to disturbances
- Loss of fish habitat through presence of foundations, scour protection and inter-array and export cable protection

However, SSACN are concerned that there has been little or no research to date regarding the potential impact on Scottish fish stocks through the effect of electromagnetic fields (EMFs).

EMF is of special concern regarding many coastal shark species, including such as thornback ray, spurdog and tope, as they appear to use the Earth's magnetic field for navigation and their low reproduction rates mean affected populations cannot regenerate fast enough.



Given the importance of the West coast to Scotland's offshore energy programme and given the lack of knowledge and uncertainty of the precise impacts EMF may have, it is essential a precautionary approach is taken as the area:

- Has many breeding and nursery grounds for electro-sensitive species such as skates, rays and various sharks
- Holds several semi-resident stocks
- Is a migratory route for nationally important species.

Unless the necessary research is undertaken and a full review of the issues is assessed before any development, the feeding, spawning, nursery areas and migration patterns of species will remain at risk.

This would not only impact the rich diversity of Scotland's marine environment , but it would also have a significant effect on inshore commercial and recreational fishing activity and their economic input into many coastal economies.

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Appendix A

Interactions between Elasmobranches and Offshore Renewable Energy Developments (Windfarms) UK.

Dr Lauren Smith.

Over a number of decades coastal waters globally have been subject to large scale human impact (e.g. fishing, pollution, coastal development and operations (Gill, 2005). During this time, coastal elasmobranchs worldwide have suffered dramatic reductions in their numbers, which has been attributed to unregulated fishing leading to over-exploitation of the larger elasmobranch species and degradation of functional habitat (Walker & Hislop 1998, Rogers & Ellis 2000, Myers & Worm 2003).

Of particular concern is the destruction and degradation of feeding and spawning grounds and nursery areas of the many species of elasmobranch that require such areas for completing their life cycle (ICES 1996). When this is added to the small number of recruits and long maturation periods typical of the elasmobranchs then populations cannot recruit individuals fast enough to replace those lost to overexploitation, pollution and habitat degradation (Camhi *et al* 1998).

Offshore Renewable Energy Developments (ORED) impact on coastal environments around the UK occupied by several elasmobranch species including commercially important species such as *Raja clavata* (thornback ray), *Squalus acanthias* (spurdog) and *Galeorhinus galeus* (Tope).

With present technology the electricity generated by an ORED is transmitted between devices and to the onshore network via 50Hz high voltage alternating current (AC) or direct current (DC) cables. The electricity transmitted through the cables will emit electromagnetic fields (EMFs) (Gill & Kimber 2005) even when the cables are properly earthed, this is because an AC power system is being used and therefore the changing magnetic field (either against time or position in space) will generate an induced electric field (Maxwell's time-harmonic equations) (Gill *et al* 2012).

Elasmobranchs possess sub-dermal pores known as the "ampullae of Lorenzini" these are electro-receptive units capable of detecting weak electrical stimuli.

Previous studies demonstrate that the ampullary system can be used to detect the bioelectric fields from prey, conspecifics and potential predators (Kalmijn 1971, 1982, Tricas 1982, Blonder and Alevizon 1988, Tricas *et al* 1995, Sisneros *et al* 1998), temperature and salinity gradients (Parker 1909, Dotterweich 1932, Sand 1938, Hensel 1955, Murray 1957, 1960a,b, Loewenstein 1960), and that the ampullary electro-receptor system mediates the orientation of the animal to local inanimate electric fields (Kalmijn 1974, 1982, Pals *et al* 1982) theorised to function in geomagnetic navigation (Kalmijn 1974, 1988, 2000, Paulin 1995).

It is known that elasmobranchs can respond to magnetic fields of between 25-100 µ Tesla (Meyer *et al* 2004) and are thought to use the Earth's magnetic field (approximately 50 µT) for navigation.

A simulation using an industry standard cable of 135kv, 18cm diameter, buried 1m into the seabed and in a water depth of 20m, was shown to emit a magnetic field outside the cable of 0.001 µT – 10 µT (Gill et al. 2012), this figure is lower than the magnetic field created by Meyer et al 2004 but a more recent study commissioned by COWRIE (Collaborative Offshore Wind Research Into the Environment) which used a magnetic field approaching 8 µT (which was associated with an induced electric field of approximately 2.2 µV/m) falls within this simulated range; a section of sub-sea cable within a suitable area of seabed using an approach known as "mesocosm studies" allowed the response's of elasmobranch test species (Raja clavata, Squalus acanthias and Scyliorhinus canicula) to controlled EMF's to be assessed within a semi-natural setting.

The results from this mesocosm study provided evidence that the benthic, elasmobranch species studied can respond to the presence of EMF that is of the type and intensity associated with sub-sea cables. However the responses were found not to be predictable and appeared to be species specific and perhaps individual specific, with some Raja clavata more likely to move around within the EMF zone associated with the cable and a number of Scyliorhinus canicula found in closer proximity to the cable restricting their movements consistent with behavioural activity associated with feeding behaviour in this species (Gill et al. 2009).

Lending further credence to the importance of looking at individual species when considering their responses to magnetic fields is a study by Kempster et al 2012, which showed that; Elasmobranchs of the benthic environment have relatively low ampullae of Lorenzini (pore) abundance, generally preying on small and often slow-moving prey, and so, a highly sensitive but low resolution electrosensory system may be adequate to identify and locate such prey items.

Coastal pelagic elasmobranchs that show the highest pore abundances generally prey on fast-moving species (Nelson 2007). Thus, a high sensitivity to electrical stimuli, in addition to a highly resolving electro-sensory system may enable them to identify and effectively track the movements of prey in open water. Deep-water pelagic and oceanic pelagic elasmobranchs, for whom visual cues are thought to be of great importance (Compagno 1984, Lisney & Collin 2007), generally show reduced pore abundance. A greater reliance on visual cues and other senses may negate the need for such a high resolution electro-sensory system. Variations in pore abundance within specific habitats will probably relate to niche differences in diet composition and feeding behaviour (Kempster et al 2012).

In conclusion, existing studies indicate that elasmobranches are capable of detecting and responding to the EMF's created by sub-sea cables associated with offshore wind farms.

However, further study is imperative in order to understand both the short term and the long term behavioural responses shown by those species already tested and other key species such as Galeorhinus galeus, for instance :

- Will animals show habituation to the EMF overtime or will a sustained attractant/repellent behavioural response remain?
- Does ontogeny affect the behavioural response?
- Will the presence of EMF's affect the ecology of the species (for example their feeding/mating behaviours) and is there potential for this in turn to effect the ecosystem within an area occupied by an OWF following any possible increase or decrease in elasmobranch numbers?

Furthermore with plans in existence for transmissions of much higher voltage and collaborative E.U. "Supergrid's" with cables transmitting up to 400kv (Sarkar 2012), such studies should take these new figures into consideration when investigating the behavioural responses of elasmobranches

Appendix B

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