Bundesamt
für Strahlenschutz

Spotlight on EMF Research

Spotlight on “Red rock crab (*Cancer productus*) movement is not influenced by electromagnetic fields produced by a submarine power transmission cable” by Williams et al. in Continental Shelf Research (2023)

Category [low frequency, animal study]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

Subsea power cables emit magnetic fields (MF) into the marine environment and induce electric fields in sea water. These anthropogenic fields are interfering with natural magnetic (e.g., the geomagnetic field) and electric fields (e.g., bioelectric fields). Offshore renewable energy installations have been expanding rapidly in recent years. As a consequence, more submarine transmission cables carrying more power are deployed in coastal waters worldwide, resulting in increased exposure of marine life to anthropogenic MF. Its impact on marine life has not yet been extensively investigated.

2 Results and conclusions from the perspective of Williams et al.

The study at hand [1] investigates the movement and orientation behaviour of the red rock crab (*Cancer productus*) in the vicinity of a submarine power cable and its potential impact on the crab fishery. The study was performed *in situ* under natural conditions in the Santa Barbara Channel in south California, at a water depth of 9-11m close to an energized submarine transmission cable buried up to 0.5 m deep into the ground and oriented roughly south-north. The three-phase 34.5 kV alternating current (AC) cable operates at 60 Hz. Local MF near the energized cable were quantified and mapped. Additionally, the water current speed and direction were measured.

The behaviour of crabs caught by local commercial fishermen were tested in simple elongated cages positioned at ground over the cable. At each end of the cage a rectangular baited trap was positioned. The crabs were released in the middle and could choose one of the traps to enter. On one side, they had to cross the cable, on the other side, there was no cable. In half of the experiments the cable ran east from

the release site, in the other half, it ran west from the release site. Cages positioned at a distance of about 10 m from the energized cable served as control.

A power analysis revealed that 1200 crabs (400 released west from the cable, 400 released east from the cable, 400 at the control site) were needed to confirm a small effect size with a statistical power of 80% and statistical significance of 0.05. The proportion of crabs crossing or not crossing the cable, and the proportion of crabs preferring east or west direction was statistically analysed. Multiple linear models were used to explore variables influencing the results at most.

Magnetic field strength near the seafloor was variable along the energized cable, peaking at about 1.2 µT at an exposed section of the cable, and was at background level in all locations further than 90 cm from the cable.

Altogether trials with 1183 crabs were performed, 750 of them in cages on the energized cable and 433 in cages without a cable. 720 of the 750 crabs entered one of the two traps. They did not show any preference to cross the cable or not, 49,2% crossed the cable. At the control site, the crabs travelled westwards at a significantly higher proportion (75,3%). In the cable area the crabs also preferred to move to the west, independently on the presence of the cable, but the percentage (68,0%) was statistically significantly lower than on the control site. Magnetic field strength and water current velocity were both not significant predictors for cable crossing preference and travel direction. The authors hypothesized that the preferential westward movement of crabs in this area may be due to environmental cues from the surrounding habitat, including odour cues delivered by the water current, which was in the study area near the seafloor predominantly from the west.

The authors conclude that the artificial magnetic field generated by a 34.5 kV AC submarine cable is unlikely to affect crab capture rates. The results on motion behaviour suggest that the crabs are following environmental cues, such as the current or odour trails, rather than responding to the artificial magnetic field.

3 Comments by the BfS

Published results on the effects of magnetic fields on invertebrates are inconsistent. Several studies found no effects, while others report effects in certain species or under certain conditions [2]. Field studies are particularly rare. The present study contributes no evidence that submarine cable would affect crab movement under natural conditions. This outcome is supported by the fact that the present study confirmed results of a similar study preformed at the same location several years ago [3].

The authors took care to control environmental influences as far as possible, but in a field study this is not completely practicable. There were local differences between experimental and control sites causing differences in crab directional preferences, which cannot be explained by the presence of the cable. Linear models have shown, that there is no correlation with magnetic field strength and water current flow velocity. As neither magnetic field vector nor water current flow direction were included in modelling, it is difficult to interpret directional cues.

In crustaceans (e.g. crabs, lobster or crayfish), magnetic sense and the orientation according to the geomagnetic field is well investigated in spiny lobsters [4, 5], but it is not known if crabs use the geomagnetic field for orientation. If so, one would expect the orientation to be affected under the strong alternating magnetic fields measured close to the cable, but this was not the case. The authors hypothesis that the crabs tend to move against the predominant water flow from east to west following olfactory cues, seems plausible.

The study is well designed, the sample size sufficient, the methods adequate, and it is performed in the natural environment. Thus, the study provides a valuable contribution to the investigation of the influence of anthropogenic EMF on the marine environment.

References

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