

## Technical Summary

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| Study Title                       | Supplemental Data Regarding the Behavioral Response of Rock Crabs to the EMF of Subsea Cables and Potential Impact to Fisheries   |
| Report Title                      | Supplemental Data Regarding the Behavioral Response of Rock Crabs to the EMF of Subsea Cables and Potential Impact to Fisheries   |
| Report Number(s) (OCS Study)      | BOEM 2023-005                                                                                                                     |
| Completion Date of Report         | November 2022                                                                                                                     |
| Number of Pages                   | 24                                                                                                                                |
| Award Number(s)                   | M21AC00001                                                                                                                        |
| Sponsoring OCS Region or Office   | Pacific                                                                                                                           |
| Applicable Planning Area(s)       | Southern California, Central California, Northern California, Washington/Oregon                                                   |
| Fiscal Year(s) of Study Funding   | FY 2021: \$239,994.57                                                                                                             |
| Costs by Fiscal Year              | FY 2021: \$134,896.98, FY 2022: \$105, 097.59                                                                                     |
| Cumulative Project Cost           | \$239,994.57                                                                                                                      |
| Project Manager(s)                | Daniel J. Pondella, Jonathan P. Williams, Erin M. Jaco                                                                            |
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| Keywords                          | Rock crabs, EMF, subsea cables, fisheries, magnetic fields, marine renewable energy                                               |

**ABSTRACT:** In recent years, marine renewable energy (MRE) planning has increased pace in the United States, and it is increasingly important to anticipate the results of these infrastructure projects on the marine environment and local fisheries as MRE development continues. This study supplements and builds upon the findings of previous studies of red rock crab behavior to increase our understanding of potential consequences that renewable energy projects may have to commercial harvest. We quantified and mapped local magnetic fields near an energized cable, performed 1,209 experimental trials using red rock crabs (*Cancer productus*) to determine if the energized cable altered crab responses, and described and quantified variables that were most likely to affect crab responses. Crabs did not avoid crossing energized cables, and neither the cable nor the associated magnetic fields altered the direction crabs traveled. The results suggest that the artificial magnetic field generated by submarine power cables used in MRE projects are unlikely to affect crab harvest rates.

**BACKGROUND:** The need for diversity and flexibility in sources that support the energy grid while combating climate change has amplified the need for renewable energy sources. It is increasingly important to anticipate the results of these infrastructure projects on the marine environment and local fisheries as marine renewable energy (MRE) development continues. One potential impact of MRE development is a localized change in electromagnetic fields (EMF). EMF from power cables can affect a variety of marine organisms, causing behavioral, developmental, and physiological changes. Most studies on EMF effects have focused on the responses of fishes, and strong conclusions about how EMF affects invertebrates are lacking. Crabs may be subject to stronger and more direct EMF currents as they traverse the sea floor. Because the US West Coast is both a hot spot for emerging MRE development, as well as home to the largest crab fisheries in the nation, there is an obvious concern on the potential impact development will have on fisheries. Crab fishers are particularly concerned that EMF from subsea cables may reduce catch by creating de facto “electrified fences” that deter crabs from crossing over cables to get to baited traps. A previous study found that crabs would cross an energized cable to get to a baited trap but did not control for stimuli other than EMF. This report builds upon the goals, experimental design, and findings of the previous study.

**OBJECTIVES:** Quantify and map local magnetic fields near an energized cable at the study site, determine if the energized cable altered crab responses, and describe and quantify variables that were most likely to affect crab responses, including water current direction/velocity, magnetic field strength, and physical characteristics of each crab.

**METHODS:** We measured current speed and direction *in situ* using an acoustic doppler velocity meter, measured local magnetic fields at the seafloor along the 36-m running length of energized cable, and measured magnetic field strength during every experimental trial. Experimental cages consisted of two baited, rectangular crab traps connected by a mesh tunnel. Cages were placed in a control area away from submarine cables and artificial magnetic fields or along an energized cable, where they were situated on the substrate so that the energized cable was directly under the opening of one trap. Crabs were placed equidistant from the two traps at either end of the cage and allowed to enter their trap of choice. We tested if the presence of an artificial magnetic field affected the rate to which crabs entered a trap or influenced the direction of crab travel and determined if there were significant predictors of the rate of cable crossing or direction of travel.

**RESULTS:** We created a visual representation of magnetic field strength along the length of the cable within the survey area and determined that magnetic field strength decayed rapidly to background levels within ~1 m distance from the energized cabled. We also determined that magnetic fields were consistent over time along the cable and nearly non-existent in the control area. Water currents were predominantly from the west-northwest to the east-southeast at about 1.5–2 cm/s. We ran 1,209 experimental crab trials (750 along the cable, 459 in the control area) and determined that crabs showed no preference for whether or not to cross the cable as they crossed the cable in nearly half (49.2%) of the trials. Crabs showed a strong overall preference for traveling to the west (68.0% of all trials). The preference was even greater in the control area (75.3%) than the cable area (63.9%), though magnetic field strength was not a significant predictor of the crabs’ choice of travel direction, nor was any other tested variable.

**CONCLUSIONS:** We believe this is the first time that magnetic fields produced by a submarine cable have been quantified and illustrated across the seafloor *in situ*, and the results may indicate that (assuming consistent power transmission) measurements over a single time period may be sufficient for modeling the artificial magnetic field. We were also able to model the magnetic field strength-distance to cable relationship and determined that the magnetic field decayed to background level just 0.9 m from the energized cable suggesting that burial of submarine power cables to 1 to 2 m depth may be an effective strategy for reducing the magnitude to which magnetic fields interact with the local environment. Crabs did not show any preference or aversion to crossing the energized cable and showed a strong preference

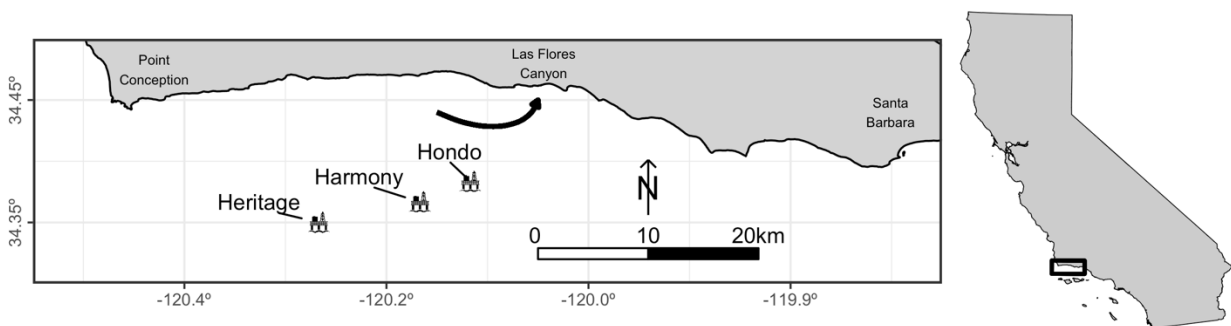
to travel to the west against the flow of the predominant measured current. Overall, our results were remarkably similar to that of the previous study, something rarely observed during *in-situ* experimentation. This study suggests that the artificial magnetic field generated by MRE-associated submarine power cables is unlikely to affect crab harvest rates.

### STUDY PRODUCT(S):

1. **BOEM study report:** Williams JP, Jaco EM, Scholz ZM, Williams CM, Pondella DJ, Rasser MK, Schroeder DM. 2022. Supplemental data regarding the behavioral response of rock crabs to the EMF of subsea cables and potential impact to fisheries. Camarillo (CA): US Department of the Interior, Bureau of Ocean Energy Management. 24 p. Report No.: OCS Study BOEM 2023-005.
2. **Short film by Shaun Wolfe of Shaun Wolfe Photography:** “Can Crabs Cross Submarine Cables?” Available for viewing at <https://youtu.be/dZWCQctUNS4>

### Map of Study Area

This study took place in southern California in the Santa Barbara Channel, offshore of Las Flores Canyon, where a 20.3-cm diameter submarine transmission cable lays partially exposed at a depth of approximately 9–11 m of water in a roughly north-south orientation (**Figure 1**). This alternating current (AC) cable operates at 34.5 kV and distributes power offshore from Las Flores Canyon to oil platforms Heritage, Harmony, and Hondo.



**Figure 1. Map of the Las Flores Canyon study site.**

The study site (indicated by the arrow near Las Flores Canyon) is approximately 35 km from Santa Barbara and 40 km from Point Conception, California, and is bisected by a power distribution cable that leads to oil platforms Heritage, Harmony, and Hondo.