Executive summary

WGELECTRA met three times (22–24/10/2014; 10–12/11/2015, and 17–19/01/2017) to discuss the ongoing research projects in Belgium, the Netherlands, and Germany and provide an overview of the state of the art knowledge of the ecological effects. Pulse trawls are used in the North Sea fishery for flatfish and brown shrimp. The shrimp pulse applies a low frequency pulse that invokes a startle response (tailflip) in shrimps. The sole pulse applies a higher frequency that invokes a cramp response that immobilise the fish species facilitating the catching process. The use of electricity in fishing has raised considerable concern among stakeholders which is mainly focused on the unknown effects on marine organisms and the functioning of the benthic ecosystem but also altered fishing efforts & catch efficiencies.

A number of laboratory experiments have been carried out in which a selection of fish species and invertebrate species have been exposed to electrical stimuli to study possible adverse effects. The maximum pulse treatment applied exceeded the strength of the pulse used by the fishery. Electrical stimulation did not cause direct mortality during exposure. Exposure to the sole pulse stimuli invoked vertebral fractures and associated haemorrhages in roundfish species (cod), but not in flatfish species (sole, plaice, dab) or seabass. The results suggest that fractures are restricted to the larger size classes of cod that are retained in the net, whereas smaller cod that can escape through the 80 mm meshes did not develop fractures even when exposed to high field strength. The fracture incidence in cod increases with field strength and decreases with pulse frequency. Fracture incidence varied between experiments. Experimental induced fractures corresponded to fractures observed in cod and whiting sampled from commercial pulse trawls. Further studies are required to study the relationship between the fractures and the body size and determine the differences in fractures across fish species. Shrimp pulse exposure did not invoke fractures in roundfish or flatfish species.

Histological examination of fish exposed to pulse stimuli in laboratory experiments, did not reveal other abnormalities in species examined, except for a small haemorrhage in 2 of the 25 exposed plaice, and a significant increase in melanomacrophage centres in the spleen of cod exposed to the shrimp pulse 24 h after exposure. No adverse effect could be detected on the electro-sense organ used in food detection behaviour of small-spotted catshark. In an experiment exposing brown shrimp and ragworms to a sole pulse showed no consistent adverse effects, but shrimps that were exposed 20 times during a 4-day period to a sole pulse showed an increased mortality compared to one of the control treatments, but not compared to the 2nd control treatment or to mechanically stimulated shrimps.

Little is known on the effects of electrical stimulation on the development of eggs and larvae. One experiment exposing early life stages of cod (egg, larvae, early juveniles) to a pulse stimulus exceeding the pulse used in the fisheries did not find an increase in developmental abnormalities in exposed animals, but observed a reduced hatching rate and an increased mortality in 2 out of the 8 experiments. No adverse effects were observed in sole eggs and larvae.

No studies have been done on the effect of pulse stimulation on the functioning of the benthic ecosystem and nutrient dynamics. Although the laboratory experiments suggest that fish and invertebrates resume their normal behaviour after exposure, no information is available on for instance the threshold levels at which the functioning of species is being adversely affected.

Electrical stimulation changes the species selectivity of the trawl. The catch efficiency of the pulse trawl for sole is higher, and the catch efficiency for plaice and other fish species is lower, when expressed in terms of the catch rate per swept area. It is uncertain whether the pulse trawl has a better size selectivity (reduced bycatch of undersized fish), but all experiments show that the bycatch of benthic invertebrates is substantially reduced. Applying electrical stimulation in the fishery for brown shrimp, offers a promising innovation to reduce the bycatch of fish and benthic invertebrates, while maintaining the catch rate of marketable sized shrimps. The reduction in bycatch depends on the design of the net, in particular the specifics of the groundrope.

In ecological terms, the replacement of the tickler chain beam trawl with pulse trawl with electrodes diminish the mechanical impact of trawling on the North Sea benthic ecosystem. Although the irreversible effects of electrical stimulation seem to be restricted to the vertebral fractures in cod and whiting, further research on the effects of electrical stimulation on marine organisms and ecosystem functioning is needed to assess the effects on the scale of the North Sea.