

History of Seismic Surveys and Fish

Marine seismic surveying has occurred globally for decades successfully coexisting with fisheries. It is important to note that in more than six decades of extensive seismic surveying worldwide, there is no evidence to indicate that typical seismic surveying activity using compressed air sources can result in death or serious injury to fish. The use of the phrase “typical seismic surveying activity” is an important distinction as numerous studies (e.g. McCauley et al. 2003, McCauley et al. 2008, Popper et al. 2016) have created scenarios where fish were subjected to numerous passes, successive passes in a limited time window, caged and unable to move away, or similarly unrealistic study conditions which would not occur with normal survey activity. Effects detected in these studies must be addressed with caution, because the conditions are manufactured and not representative of commercial seismic surveying activity.

There is a long history of seismic surveying in many regions where fisheries thrive – notably the United States Gulf of Mexico, Norway, and Canada, among others. The economically successful and productive fisheries in these regions strongly suggests that seismic surveying has no more than a negligible impact on fisheries, and that these industries can, and indeed do coexist. It is scientifically unlikely that declines in catch and productivity can be attributed to seismic surveying. Observed declines are far more likely a result of environmental changes and/or overfishing for commercially important species.

Are there Physical Impacts to Fish from Seismic Surveys?

A key 2019 (Popper and Hawkins) scientific review suggests that Sound Pressure Levels (SPL) below 230 dB re 1 μ Pa, and Sound Exposure Levels (SEL) below 200 dB re 1 μ Pa are unlikely to produce injury or hearing damage. There is no evidence that compressed air seismic sources pose a threat to fishes under normal survey operations. Hearing impairment is possible, but temporary. While fishes can experience temporary hearing impairment, called temporary threshold shifts (TTS), permanent hearing loss, called permanent threshold shifts (PTS) appear unlikely because fishes can repair or replace damaged or lost sensory cells. Normal hearing is recovered within a span of hours to days.

While it is possible that fish may be more vulnerable to predation while experiencing TTS, no evidence suggests that this is biologically meaningful on a population scale. Behavioral self-mitigation (i.e., avoiding unpleasant stimuli) is likely to minimize the potential for these interactions even further.

Some studies have shown that various life stages of fish may be physically affected by exposure to seismic surveys, but in all of these cases, the fish were very close

to the seismic source or subjected to exposures that are extremely unrealistic for free-ranging fishes.

What are the Behavioral Impacts to Fish from Seismic Surveys?

Since typical seismic surveys are a moving sound source, any potential effects on fish are temporary and transitory, and there is no scientific evidence to suggest long-term changes in fish habitat use or distribution following seismic surveys. For example, one 2001 study (Wardle et al.) indicated that several species of fish did not move away from a seismic survey even at close range, and exhibited only a brief startle response. Most importantly, however, a response (whether an observed behavior or movement away from the sound source) does not necessarily indicate that the response is biologically significant and could be reasonably expected to have any bearing on the long-term health, fertility, or survival of the individual fish or the collective population. Merely detecting and/or responding to a sound does not unto itself indicate a negative consequence because fishes are constantly detecting and responding to stimuli in the environment.

During seismic surveys, a vessel exclusion zone is maintained around the survey vessel and its towed streamer arrays to avoid interruption of commercial fishing operations, including setting of fishing gear. These exclusion zones are dependent on the type of activity and national and local regulations in the area of operation.

Prior to conducting a seismic survey, operators work cooperatively with local fishing communities and regulatory bodies to avoid sensitive spawning grounds and mitigate any potential economic losses to fisherman. The geophysical industry works with fishermen to define and address potential concerns early in the permitting process.

What are the Impact of Surveys on Fish Eggs, Larvae and Fry?

It is unlikely that seismic surveys represent a hazard to fish eggs. Although fish eggs, larvae and fry do not have the ability to move away from a sound source, and may be injured in the unlikely event they are within a few meters of the seismic source, the impact of such a likely event is considered insignificant on a population scale compared to the high natural mortality rate of eggs, larvae and fry.



A 2009 (Payne et al.) study which carried out capelin egg exposure experiments six days after fertilization, exposing eggs to peak sound pressure levels (SPL_{pk}) of 190-200 dB re 1 μ Pa showed no significant differences in mortality between control and exposed eggs in any of the trials. In the study, the eggs were subjected to 10-30 individual pulses from the source. This level of exposure is expected to be higher than what would be experienced in the field for an actual survey because seismic vessels typically travel 4-5 knots. While literature on early life stages of fish is limited, it is reasonable to assume that effects would be limited to only within close proximity to the source.



How do Seismic Surveys Impact Zooplankton?

There has been a great deal of attention on zooplankton and potential impacts from exploration activities and seismic surveys. Despite there being little to no substantiated evidence of sound from seismic surveys doing irreparable harm to zooplankton, these claims continue to persist. Zooplankton is a key food source for many marine species, including commercially important fish. Claims regarding negative impacts from seismic surveys to zooplankton (i.e., fish larvae and their prey species) rely heavily on a paper from McCauley et al. (2017). However, a follow-up study conducted by CSIRO, in which the results of the McCauley (2017) study were presumed to reflect reality and modeled at the scale of a full-scale seismic survey, indicated that there were no discernable effects to zooplankton biomass on a regional scale (Richardson et al. 2017).

The geophysical and exploration (G&E) industry appreciates the critical role of zooplankton as the base of the food chain and is committed to conducting operations in an environmentally responsible manner.



How do Seismic Surveys Compare to Other Sources of Risk to Fish?

Separating the effects of sound from other environmental disturbances can be complex. The impacts of sound on fish stocks must be viewed in a wider context, considering how the effects of sound on populations compare to other natural and human influences on the marine environment. Those influences that are known to threaten marine life such as overfishing, disease, and habitat degradation and pollution have greater impact from an overall risk perspective.

What is the Seismic Industry Doing?

For many years, industry has invested in considerable research regarding the effects of seismic surveys on marine animals including fish. Research projects also address gaps in knowledge and assist in a more comprehensive understanding of potential environmental risks (www.soundandmarinelife.org). That investment continues today.

In addition to the research, industry employs various mitigation measures to decrease the potential impact of seismic survey operations on marine life, including avoidance of important fish spawning grounds and use of a soft-start/ramp-up procedure, which is a gradual build-up of the seismic sound source to allow fish to swim away. In the U.S. Gulf of Mexico, where seismic activities routinely occur, commercial fishing resulted in more than 146,000 jobs, and more than \$21.5 billion in sales, suggesting that commercial fisheries successfully coexist with seismic surveys.



Resources

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Environmental Stewardship

The IAGC supports and fosters science- and risk-based regulations consistent with existing practices that are proven to be environmentally responsible, effective and operationally feasible.