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Barotrauma Injury of Physostomous and Physoclistous Fish by Non-Explosive Sound and Pressure Cycling

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Abstract

Barotrauma injury has historically been a concern for fish exposed to underwater explosions and passage through hydroturbines. Recently this concern has been extended to include underwater sound generated by pile driving, particularly that generated during impact driving of larger-diameter steel casing. Description of the characteristics of sound impulses generated by impact pile driving that are a threat to fish is lacking and current protective criteria that rely on simple peak overpressure do not have a clear scientific basis and appear too restrictive. This paper considers the mechanisms for barotrauma injury to both physostomous and physoclistous fish as a function of acclimation depth and the criteria developed for protection of fish from barotrauma pressures generated by explosions and passage through hydroturbines. These mechanisms and criteria are discussed within the context of observations of impact pile driving generated pressure time histories and observations of barotrauma injury to fish made during pile driving projects on the West Coast of the United States. Also considered are the results of recent sound-mitigation efforts, including driving of steel casing pile in the dry, the use of both confined and unconfined bubble curtains, and the success of these mitigation efforts as measured by comparison with fish-protection criteria.