Aquaculture is the fastest growing food producing sector. Yet, many challenges and questions remain on how the welfare of fish can be defined, measured and ensured. While the industry requests ethically acceptable methods for handling and stunning fish prior to slaughter, little is known about how fish perceive and respond physiologically to such interferences. CO₂ is currently used to stun fish in aquaculture, but lately this method has been questioned and electric exposure has been proposed as a more ethical alternative. In the lab, we quantified physiological stress responses to these methods in cannulated Arctic char by measuring blood pressure, heart rate and ventilation whilst also collecting blood samples for cortisol analysis. The lab-based studies were complemented with an on-site study where behaviours and blood samples for cortisol analysis were obtained from Arctic char prior to slaughter in a facility running both stunning methods in parallel. The lab results confirmed that CO₂ exposure results in profound behavioural and physiological stress responses, and neither temperature reduction nor additional O₂ eases this situation. Electric exposure for 30 s resulted in a marked blood pressure increase, followed by ventilatory arrest that eventually killed the fish from cardiac ischemia. With a shorter 5 s electric exposure the ventilatory arrest was reversible, but signs of systemic stress responses, including hypertension and increased plasma cortisol levels were evident. In the on-site study, CO₂ exposure triggered aversive struggling and escape responses for 5-10 min before the fish was immobilized, while fish exposed to an electric current were instantly immobilized. On average, it took 5 min for the fish to recover from an electrical stunning, whereas fish stunned with CO₂ failed to recover. Electrically stunned fish had more than twice as high levels of plasma cortisol compared to fish stunned with CO₂. This result is surprising considering that the behavioural reactions were much more pronounced following CO₂ exposure. It is suggested that the relationship and timing of ventilatory failure and loss of consciousness following electrical stunning needs further study to ensure that welfare is not compromised. Attempts are now being made to assess stress physiology and welfare in fish using biotelemetry techniques allowing us to monitor focal animals throughout different production phases in aquaculture settings.