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ARTICLE

A Field Test of Eugenol-Based Anesthesia versus Fish Restraint in Migrating Adult Chinook Salmon and Steelhead

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Abstract

Many studies require the collection and handling of fish, which may have short- and long-term effects on their behavior and survival. We evaluated the effects of AQUI-S 20E, a eugenol-based anesthetic, on adult spring Chinook Salmon *Oncorhynchus tshawytscha* and winter steelhead *O. mykiss* in the Willamette River, Oregon. We experimentally compared the postrelease behaviors and movement into spawning tributaries of fish radio-tagged under anesthesia with those of fish radio-tagged while being manually held in a restraint device. Anesthetized Chinook Salmon were less likely than restrained Chinook Salmon to swim downstream (20% versus 47%), more likely to reascend the fishway at which they were collected (89% versus 60%), and more likely to escape to tributaries (82% versus 47%). The treatment effect persisted after statistically controlling for tag date, release time, and fish size. In contrast to Chinook Salmon, the percentages of anesthetized and restrained steelhead that moved downstream (17%), passed the dam (88–90%), and escaped to tributaries (79–83%) did not differ by handling treatment. Our results highlight that the effects of handling and tagging need to be evaluated, that such effects may be species specific and occur at multiple scales, and that eugenol-based anesthetic should be used instead of restraining devices for Chinook Salmon.

A key challenge in many fish studies is the need to collect, handle, and tag individual fish while simultaneously assuming that the sampled fish do not differ from the population of interest, that is, that there are no (or minimal,) handling or tagging effects. Fish that are handled during field research and monitoring projects are at risk of internal and external injuries, elevated stress responses, and increased postrelease mortality. These effects can be reduced, in part, by effective use of fish sedatives or anesthetics (Ross and Ross 2008). However, the use of fish anesthesia in field studies has been constrained by regulations governing potential human consumption of fish after anesthesia (Peake 1998; Schnick 2006; Trushenski et al. 2013). For example, a 21-d withdrawal period is required for fish treated with MS-222 (tricaine methanesulfonate), a widely used fish anesthetic in North America. Such restrictions are functionally unrealistic for most field studies of fish susceptible to harvest.

An ideal field anesthetic would have no adverse effects on fish, would not alter behavior compared with unhandled fish, and would pose no risk to humans exposed through consumption (Marking and Meyer 1985; Zahl et al. 2012). Recent immediate-release candidate substances have included carbon dioxide, benzocaine, eugenol (a natural compound derived from clove oil and other plants), and isoeugenol (a synthetic eugenol derivative). Carbon dioxide has been approved in the USA but has been associated with stressful blood physiology, long induction times, and poor postsurgery survival (Sanderson and Hubert 2007; Gause et al. 2012; Trushenski et al. 2012). Benzocaine is a synthetic anesthetic that has seen limited application in fisheries for several decades, primarily in aquaculture (e.g., Gilderhus and Marking 1987). Benzocaine is a potential immediate-release option, but no drug company has sponsored an approval process for fisheries applications

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