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Evaluating the Efficacy of Carbachol at Reducing Corvid Predation on Artificial Nests (Abstract)

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ABSTRACT: Nest predation often limits recovery of threatened and endangered birds, especially ground-nesting species. Accordingly, a variety of techniques are used to reduce the impact of nest predation on listed species. We examined the efficacy of conditioned taste aversion, a nonlethal technique designed to induce avoidance behavior in predators after being exposed to prey items that have been treated, usually with a chemical emetic that causes predators to become ill within minutes of consumption. We used carbachol (carbamyl choline chloride) as a taste-aversive agent to condition corvids responsible for high levels of nest predation on two federally listed species [the western snowy plover (*Charadrius nivosus nivosus*) and California least tern (*Sternula antillarum browni*)] breeding at Marine Corps Base Camp Pendleton, California. Carbachol is tasteless, colorless, and odorless, which makes it a preferred aversive agent as predators are unable to detect the chemical and therefore associate their resultant sickness with consumption of the prey item. We conducted two separate experiments in 2013 and 2014, during which we deployed 772 artificial nests during the first experiment and 760 artificial nests during the second experiment. Both experiments were conducted prior to the onset of egg laying for plovers and terns (i.e., Feb-Mar) and each artificial nest contained three quail (*Coturnix sp.*) eggs. During the first stage of both experiments all of the nests only contained untreated quail eggs, and nest predation was high with >90% of nests failing within 1-2 days of deployment. In subsequent stages, we deployed carbachol-treated eggs in increasing proportion. We used nest survival models to evaluate daily survival rates (DSR) of artificial nests in all stages of both experiments. During both experiments, DSR increased concomitant with a greater proportion of carbachol-treated eggs. Common ravens (*Corvus corax*) accounted for 98.1% (n = 471) of all artificial nest predations in Experiment 1, and 95.6% (n = 498) of all artificial nest predations in Experiment 2. Using carbachol as a taste-aversive agent was effective at reducing predation on artificial nests as illustrated by increased DSR (0.47 to 0.98 in the first experiment and 0.00 to 0.99 in the second experiment); however, transferability of this technique to plover and tern nests was not fully realized.

KEY WORDS: California, *Charadrius nivosus nivosus*, common raven, conditioned taste aversion, *Corvus corax*, least tern, nest survival, predator management, snowy plover, *Sternula antillarum browni*

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