Influence of release season on size-dependent survival of cultured striped mullet, *Mugil cephalus*, in a Hawaiian estuary

Kenneth M. Leber
The Oceanic Institute
Makapuu Point, Waimanalo, Hawaii 96795
Present Address: Mote Marine Laboratory
1600 Ken Thompson Parkway, Sarasota, Florida 34236
E-mail address: KLeber@marinelab.sarasota.fl.as

H. Lee Blankenship
Steve M. Arce
Washington Department of Fish and Wildlife
600 Capitol Way North, Mail Stop 43135
Olympia, Washington 98501-1091

Nathan P. Brennan
Tennessee Cooperative Fishery-Research Unit
Tennessee Technological University
P.O. Box 5144, Cookeville, Tennessee 38505

Abstract.—The concept that depleted populations of marine fishes can be revitalized by releasing cultured fish is being tested in Hawaii. In this study we evaluated effects of interaction between release season and size-at-release on recapture rates of cultured striped mullet, *Mugil cephalus*, released into Kaneohe Bay, Hawaii. Over 90,000 cultured *M. cephalus* fingerlings, ranging in size from 45 to 130 mm total length, were tagged with binary coded-wire tags. Half were released in spring, the remainder in summer. In both seasons, releases were made in three replicate lots. In each replicate, five size intervals of fish were released at two nursery habitats in Kaneohe Bay. Monthly cast-net collections were made in 6 nursery habitats over a 45-week period to monitor recapture rates, growth, and dispersal of cultured fish.

Recapture rate was directly affected by the seasonal timing of releases. Greatest recovery of the smallest fish released (individuals <60 mm) occurred following spring releases and coincided with peak recruitment of similar-size wild *M. cephalus* juveniles. In contrast, recovery of fish that were <60 mm at release was very poor after summer releases. Overall survival was similar at both release sites. We hypothesize that survival of released cultured fish will be greater when releases are timed so that fish size-at-release coincides with modes in the size structure of wild stocks. To optimize effectiveness of stock enhancement as a fishery-management tool, pilot release-recapture experiments should be conducted to evaluate effects of release season on size-dependent recovery of released animals.

Manuscript accepted 9 September 1996.
Fishery Bulletin 95:267–279 (1997).

With world fisheries yields in steady decline (FAO, 1992, 1994; WRI, 1996), renewed interest in stock enhancement based on marine hatchery-releases is growing worldwide. This interest follows the demonstrated impact of stock enhancement in freshwater systems (e.g. Foerster, 1936; Solazzi et al., 1991) and is coupled with rapidly expanding marine aquaculture technology (Colura et al., 1976; Roberts et al., 1978; Øiestad et al., 1985; Lee and Tamaru, 1988; Eda et al., 1990; Forés et al., 1990; Tilseth and Blom, 1992; Honma, 1993; Main and Rosenfeld, 1994; Ostrowski et al., 1996).

An experimental and careful approach is needed to ensure that hatchery releases in marine systems result, at best, in successful supplementation or replenishment of marine fish populations, or, at least, in a better understanding of system uncertainty (Peterman, 1991; Blankenship and Leber, 1995). This approach should involve an initial research phase with pilot releases to explore the effectiveness of release strategies. Before initiating a test release to evaluate stock-enhancement potential in Hawaiian coastal environments, initial research was focused on a series of release experiments to determine which release strategies yielded greater survival of hatchery fish in the wild. This approach provided a more powerful field test of the marine stock-enhancement concept by using prior knowledge about the effects of 1) fish size-at-release, 2) release habitat, and 3) release season on growth and survival (Cowx, 1994; Blankenship and Leber, 1995; Leber et al., 1996).

Evidence is mounting that release habitat, season, and size-at-release, can substantially affect success of marine hatchery releases (e.g. Tsukamoto et al., 1989; Svasand