COMPLETE OPTIMIZATION: INTREGRATING MANAGEMENT WITH HATCHERY RELEASES

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Properly integrating management with hatchery releases is critical to the success of stock enhancement efforts. Most work has focused on the optimization of hatchery reared individuals before or shortly after release (e.g., hatchery output, wild/hatchery comparisons, juvenile survival). However, without proper management of released hatchery-reared and wild individuals over longer periods, especially for exploited species, the ultimate goal of enhancing spawning stocks may be extremely limited.

The commercially and ecologically important blue crab *Callinectes sapidus* has been recognized as a candidate for stock enhancement in Chesapeake Bay. Several portions of Chesapeake Bay have provided evidence of recruitment limitation. Furthermore, over the past 15 years, the Chesapeake Bay blue crab spawning stock abundance and biomass has declined over 80% (Lipcius and Stockhausen 2002; R. N. Lipcius, Virginia Institute of Marine Science, unpublished data) with only a small portion (11-22%) of the spawning stock reaching historic spawning areas of lower Chesapeake Bay (Seitz et al. 2001), which are mostly encompassed within spawning sanctuaries (i.e., no harvest) during the summer months.

Since 2001, we have assessed the feasibility of blue crab stock enhancement in Chesapeake Bay. The survival and growth of 25 distinct cohorts (90,000 individually tagged crabs) of hatchery-reared blue crab juveniles were tracked after release in small coves within subtributaries of upper Chesapeake Bay. Additionally, numerous laboratory and field experimental were performed to determine optimal release strategies (Davis et al. 2004; Davis et al. 2005); however, post-release factors that may affect spawning stock contribution once crabs reach maturity remain unclear.

Here we report the results of a mark-recapture study to determine the timing and route of the female blue crab spawning migration in Chesapeake Bay, which will be integrated with the results of stock enhancement efforts. From 1999 to 2004, 3374 adult female blue crabs were tagged and released in the vicinity of the Rhode River, Maryland, a subtributary of upper Chesapeake Bay. Recaptures of female crabs released at monthly intervals from June-November indicated that migration occurred during a short fall period rather than over the prolonged period of summer to fall mating. The distances traveled by crabs before recapture differed significantly among release months. On average, crabs released in September and October traveled greater distances than crabs released in earlier months (June-August). Depths of recapture sites differed significantly among months, with shallow depths in June-August increasing in September to a maximum in November. The locations and bathymetry of recapture sites showed that female crabs used areas near the deep channel, especially the eastern shoulder, of Chesapeake Bay as a migration corridor to the spawning areas of the lower estuary.

The distinct fall season and route of migration provides valuable management information for protecting the declining spawning stock of Chesapeake Bay blue crabs (Aguilar et al. 2005). While the blue crab spawning sanctuary complex in Virginia waters of mainstem Chesapeake Bay may protect crabs during the spawning period, it leaves a large portion of females (especially those females moving from the upper bay) vulnerable to harvest during their fall migration. Our results provide fishery managers with specific information that regulation of fishing pressure along the migration corridor during very limited months (late September to early November, and perhaps shifting down the bay with advancing season) and habitats (depths >8 m along the mainstem channel) could have great effect in protecting migrating females. Furthermore, identifying the primary migration period will aid in determining optimal release times of hatchery-reared juveniles. For example, release times that allow crabs to reach maturity prior to the migration period should permit crabs to spawn in the year of release and possibly lower overwintering mortality risk (Rome et al. 2004). The integration of traditional fisheries management with releases of hatchery-reared juveniles should increase hatchery contribution to spawning stocks; thus, increasing the efficacy of stock enhancement efforts.

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