MORE RECRUITMENT FOR LESS MONEY:

SURVIVAL AND COST ANALYSIS FOR THREE SIZE CLASSES

OF STRIPED BASS STOCKED AT FRESH AND BRACKISH SITES

IN A SOUTHEASTERN U. S. ESTUARY

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Introduction

Restoration of the striped bass population in the Savannah River, Georgia-South Carolina, has been attempted by stocking hatchery-raised fish since 1990. Optimization of this program required information about the best sizes of fish to stock, costs associated with production of different sizes of fish, and differences in fish survival between fresh and brackish stocking sites within the Savannah estuary. This paper summarizes results for 1991-1995 and identifies fish sizes and stocking locations that maximized recruitment in relation to hatchery production costs. This study was funded by the Wildlife Resources Division of the Georgia Department of Natural Resources (DNR).

Methods

Three size classes of juvenile striped bass (15-25 mm, 50-80 mm, and 175-250 mm) were cultured at the Richmond Hill Hatchery, Georgia DNR, and Bo Ginn National Fish Hatchery, US Fish and Wildlife Service, for stocking in the Savannah River estuary (Table 1). Stockings were done annually in May (15-25 mm), late June (50-80 mm), and November-December (175-250 mm). Per-fish production costs were about $0.04, $0.41, and $1.30 (US) for the three size classes, respectively (unpublished data, Georgia DNR).

In the estuary, which extended 18-58 km upstream from the river's mouth, we annually stocked fish at sites that were either fresh throughout the tidal cycle or brackish (1-20 o/oo salinity). All stocked fish were marked either by immersion in oxytetracycline as fry (Secor et al.,1991), insertion of coded-wire microtags (Wallin and Van Den Avyle, 1996), or application of internal anchor-tags. This allowed determination of release site and initial size for stocked fish recaptured in subsequent sampling efforts.

Table 1. Number of juvenile striped bass stocked at freshwater and brackish sites in the Savannah River estuary. Short-term survival rates were measured at 48 h poststocking in cages, and long-term relative survival was measured on electrofishing catch per unit effort at age 2 per 10^6 fish stocked (CPUE).

	Freshwater stocking sites			Brackish stocking sites		
Year stocked	Number stocked (1,000s)	48-h survival	CPUE	Number stocked (1,000s)	48-h survival	CPUE
		Size at stocking = 15-25 mm				
1992	0	-	-	250	0.79	0.1
1993	0	-	-	250	0.22	1.5
1994	0	-	-	146	0.87	NA
Years pooled	0	-	-	645	0.59	0.4
		Size at stocking = 50-80 mm				
1990	48	0.30	9.4	48	0.80	2.9
1991	0	-	-	95	0.85	1.6
1992	0	-	-	150	0.95	0.9
1993	0	-	-	99	0.91	0.4
1994	24	0.08	NA	50	0.76	NA
Years pooled	72	0.23	9.4	442	0.88	1.1
		Size at stocking = 175-250 mm				
1990	17	0.62	127.2	4	1.00	30.2
1991	6	0.24	182.7	21	0.95	16.5
1992	9	0.34	66.7	32	0.46	68.9
1993	27	0.08	94.4	36	0.92	22.3
1994	20	0.05	NA	31	0.25	NA
Years pooled	79	0.23	117.1	124	0.61	30.5

In 1990-1994, 209 truck-loads of fish were delivered to stocking sites. For 143 of the deliveries (68%), we experimentally determined survival rates at 48 h post-stocking by holding fish in cages at receiving sites. We multiplied each survival rate by the number of fish delivered in the hatchery truck to estimate the number of fish effectively stocked (after 48 h). This was necessary because pre-stocking handling procedures significantly affected survival at 48 h (Wallin and Van Den Avyle, 1995), and we wanted to adjust for this effect prior to evaluating long-term survival. In deliveries where survival at 48 h was not directly estimated (66 loads), we used the average of estimates made for the equivalent fish size, stocking location, and year.

Long-term survival was estimated using data from annual spring-time electrofishing in the estuary. Electrofishing was conducted February-April 1991-1995; annual effort ranged from 86 to 136 h (pedal time). Each year, recaptures of stocked fish were counted according to stocking year, location, and initial size, and catch-per-unit-effort was calculated by dividing the number collected in each category by total sampling effort. Relative survival (CPUE) was calculated by dividing catch rates by the effective stocking rate (in millions) for the corresponding stocking year, location, and size. Analyses were limited to recaptures of stocked fish at age 2 because age-1 fish were not fully vulnerable to electrofishing sampling.

Cost-effectiveness was compared among stocking sizes and sites by estimating relative cost rates. For each sizeXsite combination, we calculated the product of short-term survival and relative survival at age 2 and divided by the production cost per fish. Results were rescaled by equating relative cost of 15-25 mm fish at brackish sites to unity and adjusting other rates proportionately.

Results and Discussion

Short-term survival rates (after 48 h in cages) varied with fish size and stocking location (Table 1). Rates (years pooled) ranged from 0.23 for the larger and intermediate size classes in freshwater to 0.88 for the intermediate size group at brackish sites. In general, short-term survival was greater in brackish water.

Relative survival at age 2 ranged from 0.4 for the smallest fish in brackish water to 117.1 for the largest fish in freshwater (years pooled, Table 1). Long-term survival generally increased with stocking size and was greater in freshwater. Exceptions were noted for stockings in 1992, when relative survival of the largest fish was similar between fresh (66.7) and brackish sites (68.9), and in 1993, when the smallest fish had higher survival than intermediate fish at brackish sites (1.5 vs 0.4).

Cost-effectiveness was greatest when the largest fish were stocked in freshwater and least for the smallest fish in brackish water (Table 2). The largest fish were 24-34 times more cost-effective than the smallest fish and 4-6 times greater than the intermediate fish. Freshwater sites were 1.5-2.0 times more economical than brackish sites, despite the generally greater short-term survival observed at brackish sites. Long-term survival advantages of freshwater stocking apparently outweighed the short-term disadvantages.

Table 2. Cost effectiveness associated with stocking juvenile striped bass of different sizes at freshwater and brackish sites in the Savannah River estuary. Effectiveness was calculated as (S•CPUE)/C, where S=48-h survival rate (years pooled, Table 1), CPUE=relative survival at age 2 (Table 1), and C=production cost per fish. Results were rescaled to produce a minimum value of 1.0.

		Cost effectiveness for fish stocked at	
Size at stocking	Production cost per fish (U.S.)	Freshwater sites	Brackish sites
15-25 mm	$0.04	NA	1.0
50-80 mm	$0.41	8.8	4.0
175-250 mm	$1.30	34.5	23.8