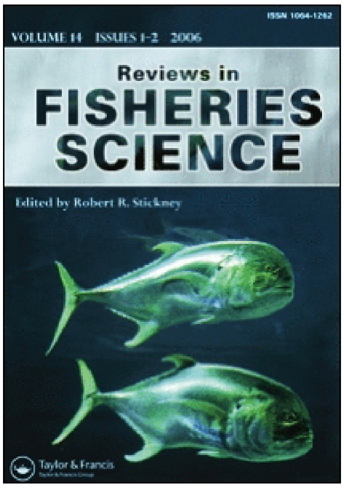

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Marine Stock Enhancement in Florida: A Multi-Disciplinary, Stakeholder-Supported, Accountability-Based Approach

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*Saltwater fishery management in Florida, USA, is mandated to include user-supported hatchery-based stock enhancement. Scientists at the Florida Fish and Wildlife Conservation Commission and Mote Marine Laboratory have taken a multi-disciplinary, quantitative approach to develop effective strategies for integrating stocking into traditional fishery management, with an initial focus on red drum (*Sciaenops ocellatus*). With consensus from stakeholders, particularly from a well-informed advisory board, focus has shifted over the past 8 years from production-oriented stocking to an assessment-driven developmental approach. The goal is to develop and expand economically successful and ecologically sound stocking technology for rapidly replenishing depleted fish stocks in a multi-billion dollar (US) saltwater recreational fishing industry. Release-recapture experiments for red drum have been underway in Tampa Bay for 6 years. This research has involved replicate stratified releases of ∼4 million red drum hatchlings, which are identifiable via genetic testing. More than 20,000 red drum tissues have been tested. These were obtained from fishery-independent and dependent sampling and from an angler-return program,. Of these, approximately 3,000 specimens have been assigned to hatchery breeding pairs. Experimental results, especially those based on hatchery fish recruited to the recreational fishery, have provided managers with valuable information about size at release, release timing, release habitat, and post-release movement.*

Keywords adaptive management, genetic identification, red drum, *Sciaenops ocellatus*

INTRODUCTION

In Florida, USA, saltwater recreational fishing is a multi-billion dollar (US) industry, with a greater economic output than in any other state in the United States (American Sportfishing Association (ASA), 2006). Habitat protection and fishery assessment and regulation have long been at the forefront of management efforts by the Florida Fish and Wildlife Conservation Commission (FWC). In addition, a sizeable investment has been allocated to develop an effective marine fish stocking technology for rapid restoration of depleted stocks. In 1985 the Florida Legislature provided funding for a marine fish stocking program at the Florida Fish and Wildlife Research Institute (FWRI), a division of the FWC, in partnership with Mote Marine Laboratory (MML). The new program, supported initially by general revenue and later by fishing license revenue, began with rigorous attention to the research needed to develop aquaculture technology and resolve critical uncertainties about stocking effectiveness (Blankenship and Leber, 1995; Willis et al., 1995; Neidig et al., 2000). The focus of the program has been on red drum, with some research on snook and potential future interest on spotted sea trout.

FWRI's approach of evaluating the efficacy of stocking red drum (*Sciaenops ocellatus*) before expanding the stocking

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program was accepted by stakeholders for several years. The test sites used for most of the pilot experiments were in reasonably good red drum nursery habitats in Volusia County (along Florida's central-east coast). However, public pressure soon mounted to suspend this approach. Powerful stakeholders called for massive releases of small red drum hatchlings (20–40 mm total length) in Miami (along Florida's southeastern coast; see Wickstrom, 1993) instead of continuing to evaluate optimal size at release (SAR), which involved releasing fewer, but larger, fish. Due to this public pressure, the agency relocated the stocking program to Miami and began stocking hundreds of thousands of small, untagged red drum into Biscayne Bay. In addition, some larger fish were reared, tagged with coded wire (CWT) and/or internal anchor tags, and released. Little effort was mounted to track the fate of the small hatchlings. This form of stocking, without a strong research and assessment framework, continued for several years.

Two events, a scientific peer review of the program in 1992 and the publication of "A Responsible Approach to Marine Stock Enhancement" (Blankenship and Leber, 1995), significantly influenced the program's direction. The peer review, conducted by an expert panel, concluded that exemplary progress had been made in developing a facility and in assembling a staff of specialists. However, they recommended a strategic plan be developed that clearly defined such issues as accommodating public input, selecting candidate species, identifying specific management objectives, managing genetic diversity, and developing protocols for a full-scale hatchery program. Blankenship and Leber (1995) provided guidance for these and other components considered essential to manage and optimize a responsible stocking program.

In the mid 1990s, buttressed by scientists and managers at FWRI and MML seeking a science-based approach, adaptive management principles (Hilborn and Walters, 1992) were applied to the stocking program in Biscayne Bay. In 1994 FWRI commissioned an independent study of the fate of the stocked fish. Investigators from the two-year study concluded that stocking small red drum into this system was ineffective, and they recommended stocking larger red drum (Serafy et al., 1999). In 1997 FWRI and MML scientists also began studying the effects of SAR and release habitat on the survival of red drum stocked in Biscayne Bay. Their data, collected for up to two years after releases, also yielded no evidence of small red drum survival. Consistent with the findings of Serafy et al. (1999), the data clearly showed that much larger fish (>250 mm total length) released into certain habitats survived and entered the local recreational fishery (W. Halstead, K. Leber, and C. Neidig, unpublished data; Miami Herald, 1999). This information was used by the agency in 1998 to seek consensus from stakeholders to move the stocking program out of Biscayne Bay and into Tampa Bay, which offered suitable juvenile red drum release habitats.

Gaining stakeholder support for moving a stocking program away from a heavily populated city was a difficult endeavor. FWRI achieved this by bringing stakeholders directly into the planning process through the establishment of the Marine Stock Enhancement Advisory Board (MSEAB).

Marine Stock Enhancement Advisory Board. In 1998, a panel of stakeholders was assembled to assist administrators and biologists with programmatic issues. Their three main objectives were to review and revise current stocking practices, foster angler involvement, and develop a long-term enhancement strategy. This twelve-member advisory board was composed of representatives from the saltwater fishing community, conservation groups, recreational fishing guides, and former FWC commissioners. At the first meeting of the MSEAB in May 1998, a decision was made to discontinue stocking in Biscayne Bay but to continue the monitoring and assessment of the ∼1.6 million fish already released. Additionally, program managers and the Board agreed to a pilot red drum release project in Tampa Bay to take advantage of a system less affected by anthropogenic disturbances of red drum nursery habitats. The specific objectives of the program were hierarchical: first to quantitatively and adaptively develop and refine the science of stocking red drum, then to develop a cost-based model of the potential economic benefits of stocking red drum, and finally to use that information to implement an economically feasible and ecologically sound large-scale stocking effort to positively impact recreational catch rates of red drum.

In addition to the issues on the quality of juvenile red drum habitat, there were several advantages to conducting a research-based effort in Tampa Bay. For example, there was an existing red drum fishery for which prior catch and effort data were available. Early life history studies from the proposed release areas were available for this species (Peters and McMichael, 1987). Also, FWRI had extensive juvenile and adult fishery-independent monitoring programs operating in the area. The pilot study in Tampa Bay was envisioned to be a multi-year, comprehensive investigation to determine optimal production and release protocols for an economically successful and ecological sound red drum stock enhancement program. With MSEAB approval, the experimental protocol was designed and production began in fall 1999.

Multi-Disciplinary Approach. The comprehensive research effort in Tampa Bay has involved the staffs of six separate, but integrated, research groups at FWRI and MML (Bert et al., 2003). The stock enhancement effort is but one of the many research and monitoring activities conducted by each of these groups. The specific roles of each group within the enhancement effort are, briefly, as follows:

1. FWRI Fisheries Stock Enhancement (FSE)—collects and maintains a captive red drum brood stock; produces hatchling red drum and rears them to the appropriate size for release; marks larger fish with CWT; participates in fish releases.
2. FWRI Aquatic Health Group—evaluates the health of all hatchery-reared offspring before release; assesses the health status of hatchery-reared and wild red drum in post-release surveys.
3. FWRI Fisheries-Dependent Monitoring (FDM)—routinely surveys recreational anglers to monitor catch and effort and

to discern fishery characteristics (e.g., percentage of anglers targeting red drum); obtains fin clips from harvested red drum for genetic testing.

4. FWRI Fisheries-Independent Monitoring (FIM)—systematically collects red drum of all sizes from Tampa Bay and neighboring waters via stratified random sampling and directed fishing; screens fish for the presence of CWTs; obtains fin clips or other tissues for genetic testing.
5. MML Center for Fisheries Enhancement—manages a volunteer-based fin clip program (VFP); assists FIM with juvenile monitoring; conducts telemetry studies to identify patterns of movement and habitat preferences of released fish (Neidig et al., unpublished data); assists with and helps coordinate development of FWRI's strategic plan for stock enhancement.
6. FWRI Molecular Genetics Laboratory (MGL)—develops data needed to manage genetic resources in compliance with the FWC Genetic Stocking Policy (Tringali et al., 2007; tests fin clips and other tissues from red drum captured in the project area to identify hatchery-reared red drum and the release group from which they originated.

Accountability Through Planned, Quantitative Assessment. By fully informing and involving stakeholders in the process, FWC and their partners are continually held accountable for actions, spending, and results—stakeholders determine if the program is successful or progressing adequately. For true accountability, marine stock enhancement must be treated scientifically (Leber, 1999, 2002), and the economic and wider social benefits and costs must be evaluated (Lorenzen, 2008). Our research has focused first on an empirical evaluation of the biological/technical potential for using stock enhancement in order to gain better understanding of release-strategy performance. This enables identification of optimized release strategies for field testing and modeling stock enhancement potential and economics using realistic model parameter values. Production and release strategies should be evaluated both quantitatively and economically and improved through application of inductive reasoning and active adaptive management. Accordingly, the research objectives of the pilot phase of the red drum program included empirical investigations of optimal release size, release timing, and release location. Such a process necessarily includes an accurate post-release assessment and a detailed accounting of costs associated with production, release, and post-release monitoring. Bert et al. (2003) describe the methods and protocols applied in the effort. Here we report on the progress of the program and provide preliminary results for some of the release experiments.

STUDY AREAS AND METHODS

Tampa Bay is located on the west-central coast of Florida (Figure 1). Along the eastern shore of the estuary, selected sites within the Alafia (AR) and Little Manatee (LMR) rivers served

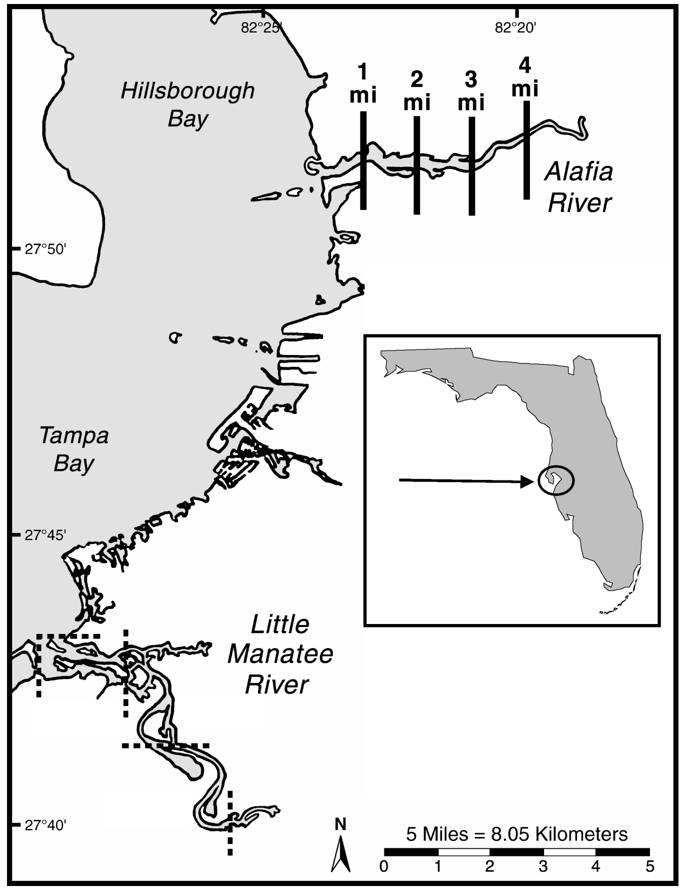

Figure 1 Location of the Alafia River (AR) and Little Manatee River (LMR) red drum (*Sciaenops ocellatus*) release sites in Tampa Bay, Florida, USA. Zones for within-river release-site experiments are indicated. Insert shows location of Tampa Bay in Florida.

as release sites. The FSE production facility, known as the Stock Enhancement Research Facility, is located 9 km south of the LMR.

Production and Release

The specific release variables examined were as follows: (1) size at release (AR only), (2) release timing (synchronous versus asynchronous with natural recruitment; LMR only), and (3) release location (within and between rivers; AR and LMR). Because recapture assignments are based largely on genetic identification, the staff of FSE was responsible for producing numerous genetically distinguishable release groups for the various experimental treatments. A total of 169 broodfish, partitioned into 34 discrete spawning groups (3 to 6 individuals per group), were used during production (Tringali, 2006).

The three SAR categories examined were: (1) phase-1 fish, 25–45 mm standard length (SL) (~1 month old); (2) phase-2 fish, 60–110 mm SL (~5 months old); and (3) phase-3 fish, 130–180 mm SL (~8 months old). All phase-1 fish were genetically distinct with respect to SAR, release timing, and release

Table 1 Summary of red drum (*Sciaenops ocellatus*) releases in the Alafia River, Florida

		River mile				
Release date	SAR	1	2	3	4	Total
03/27/00	2	3,801	3,866	3,848	3,870	15,385
04/11/00	2	3,468	3,481	3,489	3,476	13,914
04/24/00	2	3,885	3,898	3,904	3,913	15,600
06/07/00	3	931	939	938	927	3,735
07/06/00	3	931	928	933	931	3,723
12/12/00	1	20,679	0	0	0	20,679
12/14/00	1	0	48,689	0	0	48,689
06/19/01	3	4,712	4,684	5,164	4,834	19,394
07/13/01	3	5,570	5,346	4,461	5,331	20,708
12/04/01	1	91,032	0	0	0	91,032
12/05/01	1	0	81,152	0	0	81,152
04/02/02	2	7,893	8,323	7,733	7,932	31,881
04/16/02	2	2,139	1,987	2,094	2,120	8,340
11/04/02	1	0	0	0	104,976	104,976
11/05/02	1	0	0	102,896	0	102,896
11/06/02	1	59,862	0	0	0	59,862
04/10/03	2	4,991	4,804	5,046	4,962	19,803
05/08/03	2	9,694	9,711	9,578	9,423	38,406
06/04/03	3	1,501	1,511	1,499	1,543	6,054
06/16/03	3	3,021	3,071	3,018	3,018	12,128
07/01/03	3	3,947	3,861	3,890	3,838	15,536
11/12/03	1	106,316	0	0	0	106,316
11/13/03	1	0	103,329	0	0	103,329
11/24/03	1	0	0	103,488	0	103,488
11/25/03	1	0	0	0	108,780	108,780
03/23/04	2	12,257	12,189	12,278	12,203	48,927
05/20/04	2	4,543	4,524	4,489	4,328	17,884
05/25/04	2	4,437	0	4,248	0	8,685
11/29/04	1	0	102,844	0	0	102,844
11/30/04	1	102,510	0	0	0	102,510
12/08/04	1	0	0	102,697	0	102,697
12/09/04	1	0	0	0	100,848	108,848
Total		458,120	409,137	385,691	387,253	1,640,201

See text for an explanation of size-at-release (SAR) categories (phase 1, 2, and 3). See Figure 1 for a depiction of the release boundaries (river miles 1–4). All phase-1 fish released on a given date shared a common set of brood parents and were thus genetically distinguishable from fish released on other dates. Phase-2 and -3 fish were genetically distinguishable as to release date and SAR; however, assignment to a given river mile was only possible via CWT codes.

location (within and between rivers). Phase-2 and phase-3 fish were genetically distinct with respect to SAR and were further distinguishable with respect to release timing and release location via CWT.

Between January 2000 and December 2004, a total of 1,340,098 phase-1, 218,825 phase-2, and 81,278 phase-3 fish were released in the AR within one of four release grids (Figure 1, Table 1). All AR fish were released in synchrony (sync) with natural production—i.e., within the normal periodicity of early recruitment to nursery areas, associated in Tampa with a spawning season of from September to mid-November. Between August 2000 and October 2003, a total of 2,386, 879 phase-1 fish were released in the LMR within one of three release grids (Figure 1, Table 2). LMR fish were released either in sync ($n = 738{,}226$) or out of sync ($n = 1{,}648{,}953$) with natural production. Asynchronous releases were completed between May and July, about 6 months outside the time of natural recruitment.

Post-Release Assessment

Sampling programs conducted by FIM, FDM, and MML are ongoing. The various modes of sampling were described in detail in Bert et al. (2003). Briefly, the FIM group uses a stratified-random-sampling method (McMichael, 2000) to monitor finfish fauna throughout Tampa Bay. Standard FIM gears include small-mesh seines, trammel nets, and hook-and-lines. Each FIM field crew has a CWT detector aboard, and all captured red drum are scanned for the presence of a tag. Those having a CWT are retained. Red drum not having a CWT are measured and, depending on their size, fin-clipped and released (>100 mm SL) or retained whole. During the creel-survey process, FDM personnel request to obtain a fin clip from recreational anglers who indicate that they have harvested a red drum. FDM personnel have on occasion scanned harvested red drum for CWTs but do not commonly or routinely do so. Recreational anglers participating in the VFP are provided with kits with which to collect

Table 2 Summary of red drum (*Sciaenops ocellatus*) releases in the Little Manatee River, Florida

Season-year of release	Synchronicity	Number released
Summer 2000	Asynchronous	232,559
Spring 2001	Asynchronous	678,013
Spring 2002	Asynchronous	412,066
Fall 2002	Synchronous	366,015
Spring 2003	Asynchronous	326,068
Fall 2003	Synchronous	372,158
Total	—	2,386,879

All hatchlings released in this river were phase-1 red drum. All fish released on a given date shared a common set of brood parents and were thus genetically distinguishable from fish released on other dates. In the LMR, releases were conducted "in sync" or "out of sync" with natural production, as indicated.

Table 3 Summary of red drum (*Sciaenops ocellatus*) recaptures, listed by sampling source, capture gear, and identification method

Source	Capture gear	N_{TOT}	N_{GEN}	N_{CWT}	f
FIM	Hook-and-line	2,865	139	42	0.063
FIM	Trammel nets	1,717	36	0	0.021
FDM	Hook-and-line	2,354	24	1	0.011
VFP	Hook-and-line	2,989	40	na	0.013
Total		9,925	239	43	0.029

Analysis limited to specimens that were ≥200 mm SL at capture. N_{TOT} denotes the total number of specimens tested. N_{GEN} denotes the number of recaptured (hatchery) fish identified genetically. N_{CWT} denotes the number of recaptured fish identified via coded wire tags (na = not applicable). The value of f indicates the recapture probability of hatchery fish for a given sampling source $((N_{GEN}+N_{CWT})/N_{TOT})$.

fin clips and record collection data. They return fin clips to participating bait-and-tackle shops; the clips, in turn, are collected by MML volunteers.

Genetic identifications are made using the laboratory procedures and statistical assignment method described in Tringali (2006). Project-wide, more than 20,000 red drum from the FIM-FDM-VFP sampling programs have been examined thus far; among these, approximately 3,000 hatchery fish have been identified (63 via CWT detection; the rest via genetic testing). Throughout the remainder of this paper, our focus is strictly on red drum that were ≥200 mm SL at capture—it is assumed that released fish reaching this size have survived long enough to overcome short-term release effects and have grown large enough to recruit into the recreational fishery. Nearly 10,000 of these "recruitment-sized" fish have been examined thus far; among these, 282 hatchery fish have been identified (42 via CWT detection; 239 via genetic testing).

RESULTS

Recapture Probabilities by Sampling Source

We define recapture probability, f, as the number of hatchery fish detected divided by the number of fish examined, as applied here to a given sampling method or source. The highest recapture probabilities (∼6%) were observed in the hook-and-line sample obtained by the FIM program (Table 3). For specimens obtained directly from anglers, either through FDM's creel survey or MML's volunteer fin-clip program, recapture probabilities were approximately 1%. The disparity in f-values may be explained by the fact that FIM hook-and-line sampling was, for the most part, more concentrated in the upper portion of the bay (closer to the release sites), whereas the two fishery-dependent programs (FDM and VFP) operate over a broader geographic range, including southward into Sarasota Bay (∼30 km south of Tampa Bay). Notably, several hatchery red drum were recaptured in the lower portion of Tampa Bay and neighboring waters; two recaptured red drum had moved into Sarasota Bay. Therefore, the broad sampling range is justified. The level of vagility observed for hatchery fish is in keeping with that of wild sub-adult red drum. Future work will include the mapping of recapture locations and an analysis of dispersal distances.

Variable Survivorship Between and Within Alafia and Little Manatee Rivers

We define recapture rate, R, as the number of recaptured hatchery fish divided by the number of fish released, as applied here to a given treatment group. Comparison of R among treatment groups was taken as an indication of relative survivorship. Recapture rates of phase-1 fish released in the LMR were extremely low in comparison to that of fish released in the AR (Figure 2), irrespective of release timing. There was little difference between recapture rates of phase-1 LMR fish released in sync ($R = 0.0000027$) and out of sync ($R = 0.0000024$) with natural production. However, confidence in the results for the release-synchrony experiment cannot be high given that so few LMR fish (6 in total) were recaptured.

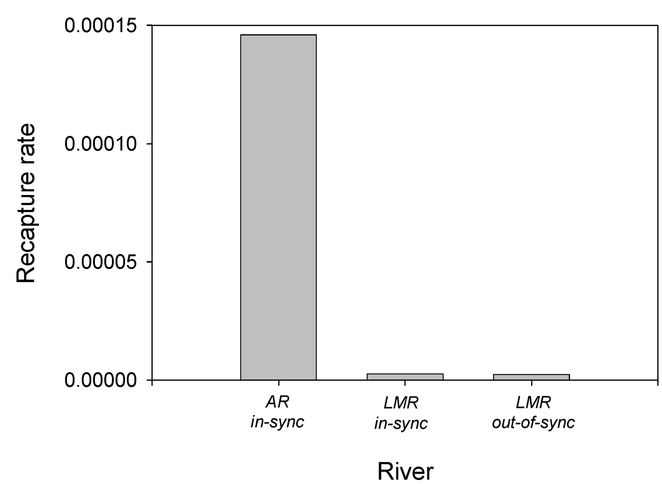

Figure 2 Recapture rates for phase-1 red drum (*Sciaenops ocellatus*) released in the Alafia River (AR) and Little Manatee River (LMR). See text for definition of recapture rate and ranges for release-size categories. LMR releases occurred in-sync or out-of-sync with natural production.

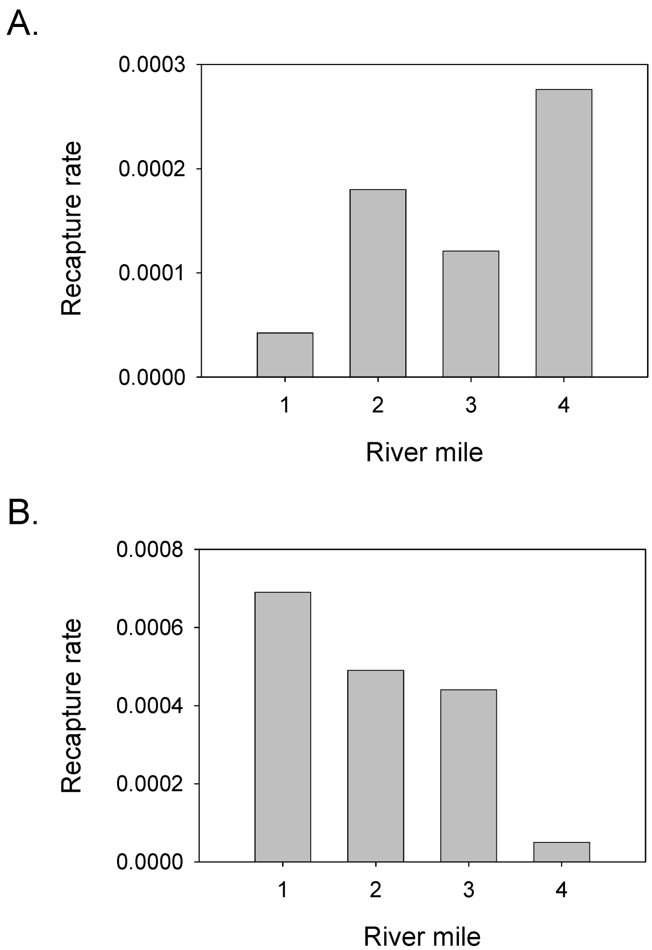

Figure 3 Recapture rates for red drum (*Sciaenops ocellatus*) released at four different sites (river miles) within the Alafia River for (a) phase-1 fish, and (b) phase-3 fish. See text for definition of recapture rate and ranges for release-size categories. See Figure 1 for the locations of the four release sites within the AR.

As of yet, too few hatchery red drum have been recaptured from the LMR treatment group for a meaningful spatial comparison of release sites within that river. Similarly, insufficient CWTs from phase-2 AR fish have been recovered (3 in total) to allow a meaningful within-river assessment for that size class (note: a greater number of caught-and-released phase-2 fish have been genetically identified via fin clips). Sufficient recapture data were available from phase-1 and phase-3 fish for a release-site analysis within the AR. From those recaptures, opposing patterns are beginning to emerge with respect to the effect of release site on the relative survival of phase-1 and phase-3 fish. The recapture rate of phase-1 fish was highest for the upriver release site and lowest for the downriver site (Figure 3a). These data suggest that the characteristics of the release site at river mile 4 (Figure 1) may be optimal for this size class, although other ecological factors may be important. Briefly, the site is a shallow, low-salinity, tidal mud flat that has a *Juncus*-dominated shoreline and is subject to freshwater influx from two adjacent canals. In contrast, phase-3 survivorship was highest for the downriver site (river-mile 1, Figure 1); R progressively decreased in the upriver direction for phase 3 fish (Figure 3b).

Effect of Size-at-Release on Survivorship

Considering only red drum released in the AR, the recapture rate for phase-3 fish ($R = 0.00086$) was approximately 6 times greater than that for phase-1 and phase-2 fish ($R = 0.00015$ and 0.00012, respectively) (Figure 4). Considering all fish released in both rivers, the recapture rate for phase-3 fish was approximately 23 times greater than that for phase-1 ($R = 0.000036$). Naturally, younger fish are subject to higher rates of natural mortality than older fish. Therefore, it was expected that recapture rates would be highest for phase-3 fish. The comparatively poor performance of phase-2 AR fish, however, was unexpected and thus far unexplained.

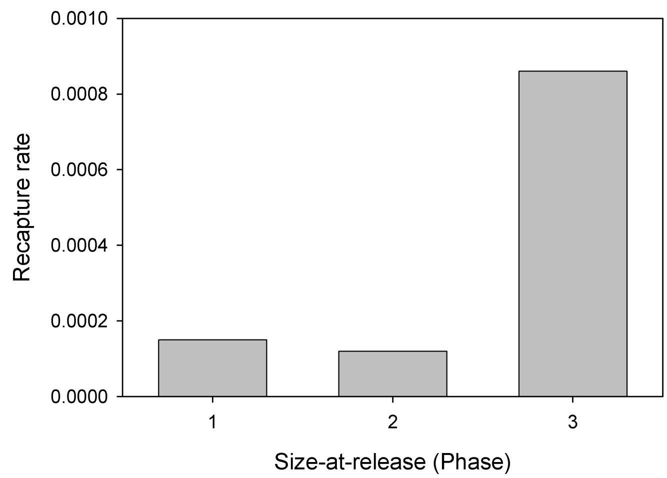

Figure 4 Recapture rates for red drum (*Sciaenops ocellatus*) released in the Alafia River at different sizes. See text for definition of recapture rate and ranges for release-size categories.

DISCUSSION

In Florida, the involvement of stakeholders directly into the planning and research processes has been an important component of red drum enhancement. Originally, the MSEAB was assembled to help redirect the stock enhancement program and was not intended to be a long-term panel. However, it quickly became evident that such a panel provided an excellent forum through which to hear the concerns and perceived needs of stakeholders, including citizens whose license money funded the program. The Board continues to meet periodically, typically once or twice a year. In turn, program managers and scientific staff provide updates and seek board consensus on adaptive-management recommendations, which can change the direction of the program to achieve program goals. Based on the success of the MSEAB, the FWC has set up similar advisory boards for other FWC programs, e.g., as part of the process in modifying Florida fishing regulations.

Stakeholders also participate in the research process itself. The recreational angling communities from Tampa Bay and nearby estuaries have embraced the red drum stocking program and assisted in the assessment effort through the volunteer fin-clip program. More than 750 anglers have participated, providing more than 3,000 fin clips to date. There are more than 85 bait-and-tackle shops distributing fin-clip kits and collecting fin clips from anglers. Recapture results are communicated to VFP participants routinely through newsletters and other contacts. Based on movements of recaptured fish, the collection range for the fin-clip program was recently extended ∼200 km northward to Crystal River and ∼150 km southward to Charlotte Harbor.

Stakeholders are being rewarded for their patience and involvement in the research process—study results have been highly informative and, at times, surprising. For example, the Alafia River and Little Manatee rivers both serve as highly productive nursery areas for wild red drum (Peters and McMichael, 1987), and there was no *a priori* expectation that survival of released phase-1 fish would differ so drastically between these two systems. Identifying the factors responsible for the comparatively good performance of phase-1 red drum released in the AR, particularly at the upriver release site, may be a key component of improving future large-scale stocking efforts involving this size class and for gaining a better understanding of red drum habitat requirements. Detailed water quality, habitat, and faunal information for all release sites are available for further analysis.

Red drum from all three experimental size classes survived over time and recruited to the recreational fishery. When considering which size class(es) to release in a scaled-up enhancement program, the temptation to view the process principally in economic terms (e.g., production cost per fish) should be resisted. Habitat availability and other ecological factors, especially carrying capacity, must also be considered. Results reported here show that predicting phase-1-fish success can be a confounding endeavor. Should it be decided to include phase-1 production as a component of a larger enhancement program in Tampa Bay, the number of fish stocked at the best AR release site cannot simply be scaled up. The challenge will be to find additional similar release locations, if enough exist, within Tampa Bay and neighboring estuaries.

Even while post-release monitoring continues, experimental findings are being coupled with associated production costs and other factors to determine the culture and release strategies for red drum that will be the most cost-effective and most likely to achieve management objectives. That we observed a 1–6% recapture probability (hatchery:wild ratio) for red drum in Tampa Bay fishery during the "experimental" phase of the program suggests that red drum enhancement is logistically feasible. The potential to positively impact red drum catch rates in Florida fisheries will be subsequently tested via a large-scale release program. It should be noted, however, that the state of knowledge does not allow prediction of an expected magnitude of that impact. The high degree of variability observed in the various empirical treatments once again supports the need for a quantitative, adaptive, and, above all, accountability-based approach to marine stock enhancement. Results of this comprehensive R&D process are thus being used to evaluate the efficacy of stocking as a fishery management tool and to model the potential economic impact of stocking on the sport fishing industry in Florida.

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