Expanding Bay Scallop Restoration in Pine Island Sound Using Competent Larvae

Final Report

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September 29, 2006

MML Technical Report #1130

MOTE MARINE LABORATORY

The Charlotte Harbor National Estuary Program is a partnership of citizens, elected officials, resource managers and commercial and recreational resource users working to improve the water quality and ecological integrity of the greater Charlotte Harbor watershed. A cooperative decision-making process is used within the program to address diverse resource management concerns in the 4,400 square mile study area. Many of these partners also financially support the Program, which, in turn, affords the Program opportunities to fund projects such as this. The entities that have financially supported the program include the following:

U.S. Environmental Protection Agency
Southwest Florida Water Management District
South Florida Water Management District
Florida Department of Environmental Protection
Florida Coastal Zone Management Program
Peace River/Manasota Regional Water Supply Authority
Polk, Sarasota, Manatee, Lee, Charlotte, DeSoto and Hardee Counties
Cities of Sanibel, Cape Coral, Fort Myers, Punta Gorda, North Port, Venice and Fort Myers Beach
and the Southwest Florida Regional Planning Council.

ACKNOWLEDGEMENTS

This project involved the participation and coordination of numerous professionals from several organizations and I would be remiss not to mention them and thank them for their efforts. Participants included: Steve Geiger, Bill Arnold, Jenessa Cobb and Carla Beals from the Florida Fish and Wildlife Research Institute, Jamie Greenawalt-Boswell, AJ Martignette, Brad Klement, Lauren Linsmayer, Justin Spinelli, and Jonathan Guinn from the Sanibel Captiva Conservation Foundation; Kendra Willett, Susan White, Lisa Vormwald, Andrew Thornton, Cheryl Parrott, Christie Sampson and Yurie Aitken from the J.N. "Ding" Darling National Wildlife Refuge; Catherine Corbett from the Charlotte Harbor National Estuary Program; and Curt Hemmel, owner of Bay Shellfish Company, Palmetto, FL. Special thanks to Don and Dorothy Golnick, owners of Demere Key, for providing facilities and accommodations for project participants throughout this endeavor. Their enthusiastic interest in our work can not go unnoticed or unappreciated.

Funding for this work was provided by the Charlotte Harbor National Estuary Program (Restoration and Research Partners Grant), South Florida Water Management District (Assistance Grant), Florida Saltwater Fishing License and NOAA Restoration Center Community-based Restoration Program (Ocean Trust).

CITATION

This report should be cited as: Leverone, JR, WS Arnold, J Greenawalt-Boswell and S Geiger. 2006. Expanding Bay Scallop Restoration in Pine Island Sound Using Competent Larvae: Final Report. MML Technical Report No. 1130.

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INTRODUCTION

Project Rationale

Pine Island Sound in Lee County, FL, is a highly prized recreational, economical and environmental resource. There is evidence, some of it anecdotal, that this system has been experiencing degradations in water quality with a resultant loss of ecological value. Two important stressors have been implicated in this deterioration process: 1) the quantity and timing of fresh water discharges from the Caloosahatchee River at the Franklin Lock and Dam (S-79); and 2) the restriction of two-way tidal flows to San Carlos Bay and Pine Island Sound caused by the Sanibel Causeway spoil islands. The U. S. Army Corps of Engineers restudy of the water supply system of South Florida is addressing the issue of fresh water releases from S-79 into the Caloosahatchee River. Construction of new bridge spans along the Sanibel Causeway began in 2004, but there are no plans to change the "footprint" of the spoil islands supporting the roadbed between the new bridges which could have changed circulation patterns in this part of the system. Regarding both these important issues, there is anecdotal evidence that the recreational bay scallop fishery was essentially eliminated by one or both of these stressors (U.S. Fish and Wildlife Service).

A recreational bay scallop fishery existed throughout the San Carlos Bay-Pine Island Sound area until the late 1980s, when scallops essentially disappeared from the area, except for a small relict population in North Pine Island Sound. The re-introduction of bay scallops has been cited as a justification for a number of possible water management strategies. A successful bay scallop restoration project, especially in southern Pine Island Sound, could serve as an important tool in evaluating ecosystem responses to changes in freshwater inflow and hydrologic alterations.

Project Background

In 2003, the first attempt at restoring bay scallop populations in Pine Island Sound was undertaken in the northern portion of the system. The results of that study were submitted to the CHNEP in 2004 (Leverone et al., 2004). In that project, approximately 1.5 million late-stage larvae (referred to as "competent" larvae) were successfully released into containment booms in the fall of 2003. (The containment booms were set up to prevent the larvae from drifting out of the area before they had a chance to settle on the bottom). Larvae that were released were shown to settle and attach to spat collectors placed within the booms. Juvenile scallops were found at the restoration site during the winter (February, 2004), and in June, 2004, adult scallop density at the restoration site was two orders of magnitude greater than the resident population within Pine Island Sound. The following summer (2005), the entire northern Pine Island Sound system experienced an additional increase in scallop density on the scale of two orders of magnitude over the previous year. As a result, Pine Island Sound had the highest population density of bay scallops of any Florida estuary that year!

Results from the 2003 restoration project demonstrated that controlled releases of competent larvae could be a viable method for ultimately restoring bay scallop populations in Pine Island Sound. Compared to previous scallop restoration projects conducted in Florida which employed different restoration procedures, releasing competent larvae has proven to be the least labor-intense and most cost-effective restoration alternative employed to date. Scallop

restoration using larval release techniques has also produced the best results of all the methods attempted in Florida.

The current project was inspired by the successful outcome of the 2003 study. In addition, this year we extended the range of restoration target sites into southern Pine Island Sound, an area which once supported historical populations of bay scallops as well. By conducting a portion of our restoration activities further south, we had the opportunity to compare results between northern and southern Pine Island Sound and discuss these differences in light of possible influences from freshwater inflow.

This project was accomplished through the participation of the following partner institutions: Mote Marine Laboratory, Florida Fish and Wildlife Research Institute, Bay Shellfish Company, Sanibel-Captiva Conservation Foundation, and the U.S. Fish and Wildlife Service J.N. "Ding" Darling National Wildlife Refuge.

PROJECT COMPONENTS

Broodstock Collection, Conditioning and Spawning

Several collection trips were made to Pine Island Sound during the summer, 2005, for collecting scallop broodstock. Sixty adult bay scallops were collected and transferred to Bay Shellfish Company in Palmetto, FL, where they were held in flow through seawater systems supplemented with cultured algae. The spawner stock was maintained under optimal conditions of temperature, salinity and food for several months until preparation for spawning.

Scallops were induced to spawn on September 23, 2005, by gentle temperature manipulations. Approximately five million fertilized eggs were produced from this spawn. Larvae were maintained according to standard hatchery procedures; growth and survival were checked daily. After ten days, the larvae had reached the “pediveliger” developmental stage, so called because they had developed a foot, indicating that they were preparing for metamorphosis. At metamorphosis, pelagic (free-swimming) larvae change into small, juvenile scallops that attach to benthic substrates. Logistical plans to release the larvae were finalized.

Larval Release

Larval containment booms were set up on October 3, 2005. Individual booms were placed at four locations within Pine Island Sound; two in the north and two in the south. Station names, locations and water quality at the time of deployment and retrieval are listed in Table 1 and displayed in Figure 1. Five spat collectors were placed inside and outside each boom and water quality measurements taken. Meanwhile, scallop larvae were transported from Bay Shellfish Company that same morning (October 3rd) in four separate 20-L carboys with light aeration. The larvae were transferred to two boats

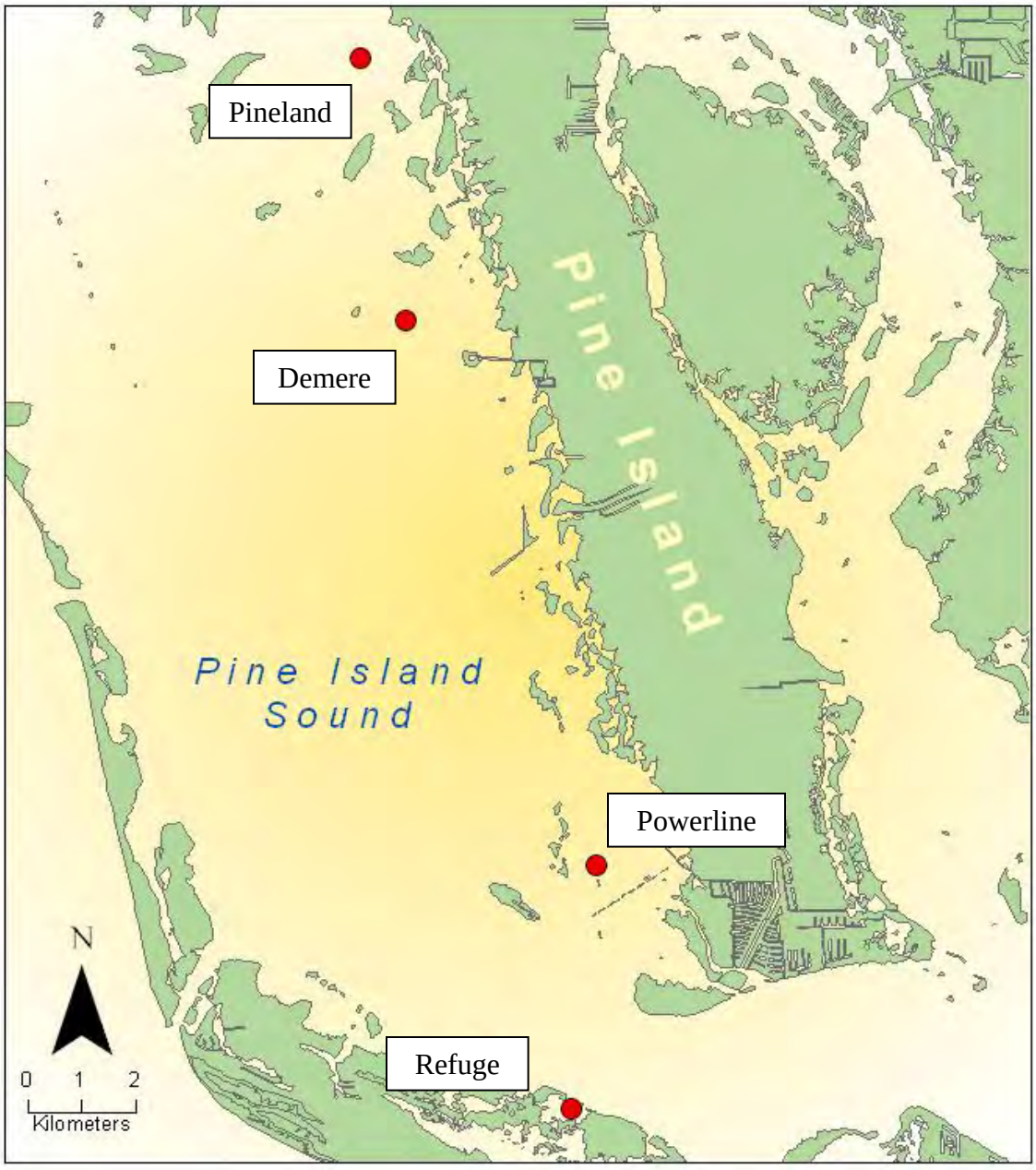


Figure 1. Locations of Pine Island Sound sites for the release of bay scallop larvae. October, 2005.

(one for the northern and the other for the southern sites), transported to location and released into the booms later that afternoon. The booms were left undisturbed and the larvae were allowed to settle within each boom for four days. On October 7, all spat collectors were retrieved and the booms carefully removed from the field. Water quality measurements were taken again at the time of boom removal.

Table 1. Deployment schedule, restoration site names and locations and water quality conditions during the Pine Island Sound bay scallop larval release project.

Boom Deployment		**Powerline**	**FWS Refuge**	**Pineland**	**Demere**
3-Oct-05	Latitude	26 30.547	26 28.130	26 38.544	26 35.948
	Longitude	82 06.770	82 07.014	82 09.996	82 06.750
	Temp (^{o}C)	28.4	28.3	28.4	28.5
	Sal (ppt)	24.3	24.3	27.2	29.7
Boom Retrieval		**Powerline**	**FWS Refuge**	**Pineland**	**Demere**
7-Oct-05	Temp (^{o}C)	28.9	28.5	29.0	29.8
	Sal (ppt)	22.0	24.1	26.5	27.4
	DO (mg/L)	5.31	2.81	3.3	7.2

Recruitment Monitoring

After each containment boom was deployed and secured, five replicate spat collectors were placed inside the boom. An additional five replicate collectors were placed outside the boom. Spat collectors consisted of 4" x 6" scrub pads which provided numerous interstitial spaces for larval attachment. Each collector was attached to a bottom weight and a surface float. The spat collector was positioned about 0.5 meter off the bottom. After the collectors were in place, larvae were dispersed into the boom. When the booms were retrieved four days later (October 7th), the spat collectors were retrieved, preserved in a 5% formalin solution and returned to the laboratory.

Before leaving each site, a buoy was attached to a line, anchored into the bottom and left behind to mark the centerpoint of each release point. In addition, the anchor screws that secured the bottom of the containment boom to the sediment surface were left in place when the booms were removed. A line was threaded through the loops of the anchor screws to mark the perimeter of the containment area. This allowed us to easily and accurately relocate each site when returning for subsequent monitoring efforts. Photographs of containment booms and hardware are provided in Appendix 1.

After seven days, the spat collectors were removed from the fixative, gently rinsed with tap water over a sieve and placed in a drying oven (105^{o} F) for 48 hours. After drying, each spat collector was gently brushed onto a sorting tray to dislodge attached scallop spat. The number of spat were identified and counted (Table 2).

Table 2. Number of scallop spat per recruitment collector for larvae released into containment booms in Pine Island Sound, October, 2005. Five collectors were placed inside and five were placed outside each boom.

	Demere Key		**Power Lines**		**Pineland**		**FWS Refuge**	
Replicate	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside
1	1	36	1	6	0	10	2	3
2	0	22	1	18	0	31	2	3
3	1	8	0	41	0	3	3	4
4	1	36	0	22	1	6	4	3
5	---	45	2	49	0	27	2	1
6	---	53	---	---	---	---	---	---
Mean	0.8	33.3	0.8	27.2	0.2	15.4	2.6	2.8

Scallop recruitment to collectors was very successful at three of the four locations. Demere Key and Power Lines had the highest recruitment, averaging roughly 30 spat per collector. Pineland had approximately half as many recruits, while FWS Refuge averaged slightly less than three spat per collector. These results were much higher than the 2003 results from Pineland, which averaged less than three spat per collector. Outside collectors at all sites had attached spat, indicating that there was some "leakage" from the containment booms. This was expecially true at the FWS Refuge site, where the high settlement outside of the boom, and probable leakage, may explain the relatively low settlement on spat collectors inside the boom. However, this did not prevent the majority of spat from settling within the booms.

These results were very encouraging for this critical phase of the project. Hatchery-produced scallop larvae were able to survive this delicate life stage, successfully make the transition from the hatchery to the field, metamorphose and "settle" out of the water column and attach to available substrate. The overall success of this restoration technique rests heavily on the ability to detect successful recruitment of released larvae.

Juvenile Scallop Survey

Three months after the scallop larvae were released, a survey was conducted to locate and count juvenile scallops. This survey took place during January, 2006. At each of the four restoration sites, the buoy marking the centerpoint and the line tracing the perimeter were located. An additional survey was conducted in the vicinity of where the scallop broodstock were collected. Each of two divers recorded the number and size of scallops encountered in ten replicate 0.25 m^2 quadrats. Each quadrat was haphazardly tossed within the perimeter of the marked line. Any additional field observations were also recorded. Water quality parameters were measured. The results from this survey are presented in Table 3.

No juvenile scallops were found within the perimeter of any larval release site. Several scallops were found outside the perimeter and divers came upon several "boxes", indicating recent scallop mortality, inside the containment area. Predators, including crabs and gastropods, were noted. Two scallops were found within quadrats at the broodstock site while quite a few more were noted while snorkeling through the area.

Table 3. Results of juvenile scallop survey, January, 2006. Survey consisted of two divers surveying ten randomly tossed 0.25m^2 quadrats at each location.

DATE	REGION	LOCATION	TEMP (^{O}C)	SAL (PPT)	SCALLOPS	COMMENTS
Jan 10	North	Pineland	18.3	31.3	0	2 "boxes" found (20 & 30 mm); abundant predators (banded tulips, echinoderms)
Jan 10	North	Pineland	18.3	31.3	0	2 adults found outside quad
Jan 09	North	Demere	16.1	32.0	0	1 scallop (25 mm) found outside quad
Jan 09	North	Demere	16.1	32.0	0	
Jan 09	South	Powerlines	16.4	31.0	0	
Jan 09	South	Powerlines	16.4	31.0	0	pair of valves (18 mm) found outside quad
Jan 09	South	Refuge	16.7	27.9	0	
Jan 09	South	Refuge			0	
Jan 10	North	Broodstock Site	17.7	32.1	1	1 juvenile (40 mm), 1 adult scallop in 15 quadrats; 9 adults with ripe gonads found outside quads

Adult Scallop Survey

Adult bay scallop surveys were conducted by underwater observation. At each location, paired divers swam a 300 meter transect line. Each diver was responsible for a one meter swath on their side of the line. All scallops were counted; heights of the first thirty scallops were measured to the nearest millimeter. Scallop abundance is reported as the number of scallops per 600 m^2, which is the total area surveyed at each location.

The Florida Fish and Wildlife Research Institute has been surveying bay scallops at twenty separate stations in north Pine Island Sound since 1994 (Table 4). In 2004, when our restoration efforts began, adult surveys were initiated at twenty stations in south Pine Island Sound (Figure 2).

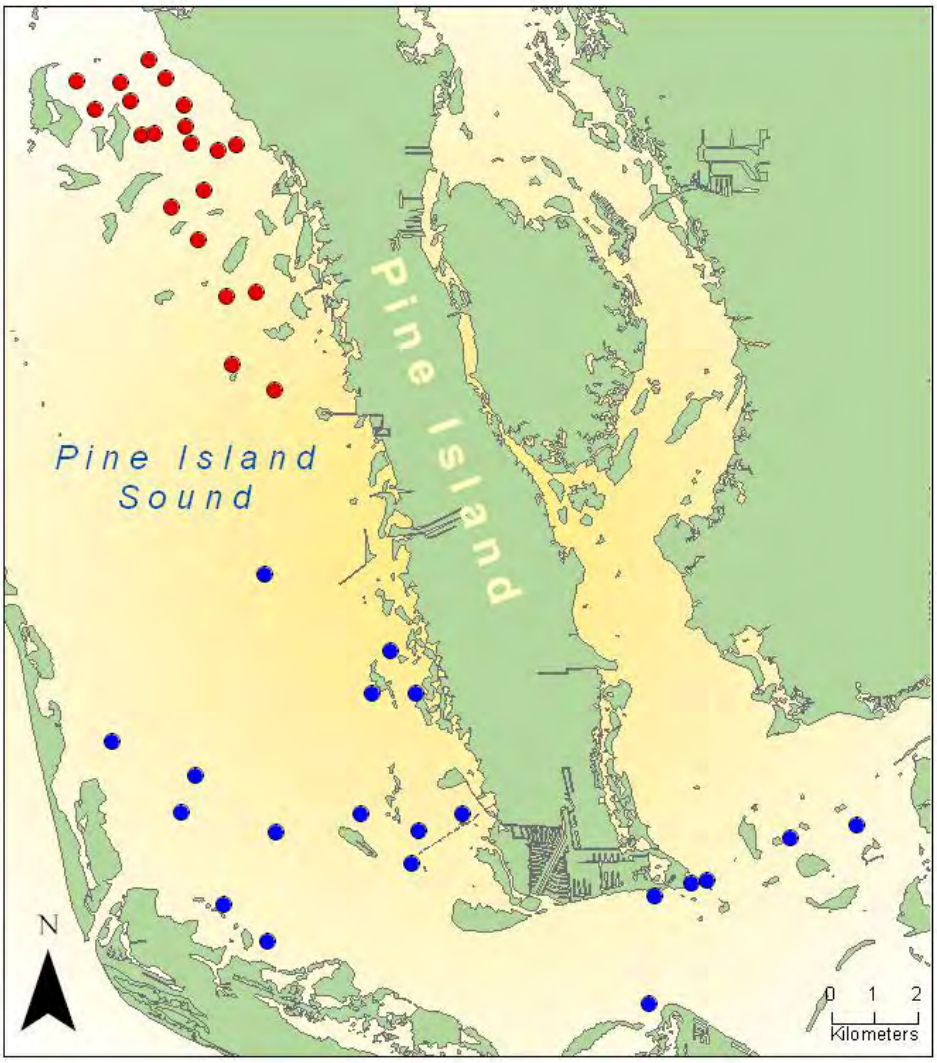


Figure 2. Station locations for adult bay scallop surveys. North Pine Island Sound (red) and South Pine Island Sound (blue).

Prior to 2004, mean annual density ranged from a high of 5.5 (2001) to a low of 0.0 (1994). Mean scallop density soared to 93.4 in 2005. This year, mean scallop density in north Pine Island Sound was 8.2. In June, 2006, the total number of scallops per 600 m^2 in north Pine Island Sound ranged from a high of 40 (Station 4) to a low of 0 (Station 18) (Table 5). Scallops were present at nineteen of the twenty stations. In south Pine Island Sound, scallops were found at half (10 of 20) the stations, with the most (6) scallops found at Station 18.

In 2003, there were very few scallops in north Pine Island Sound. In 2004, a very specific increase occurred at the larval release site from the previous year. A tremendous increase in scallops occurred throughout the entire northern sound in 2005. In fact, this area had the highest density of bay scallops in Florida for the year! Although abundance decreased significantly in 2006, we witnessed a very broad distribution of scallops throughout this part of the sound.

South Pine Island Sound was essentially void of scallops in 2004. A high density aggregate of scallops was present between Regla Island and the western shore of Pine Island in 2005. This year (2006), a low density of scallops was spread throughout this portion of the sound, particularly along the eastern coastline of Sanibel Island.

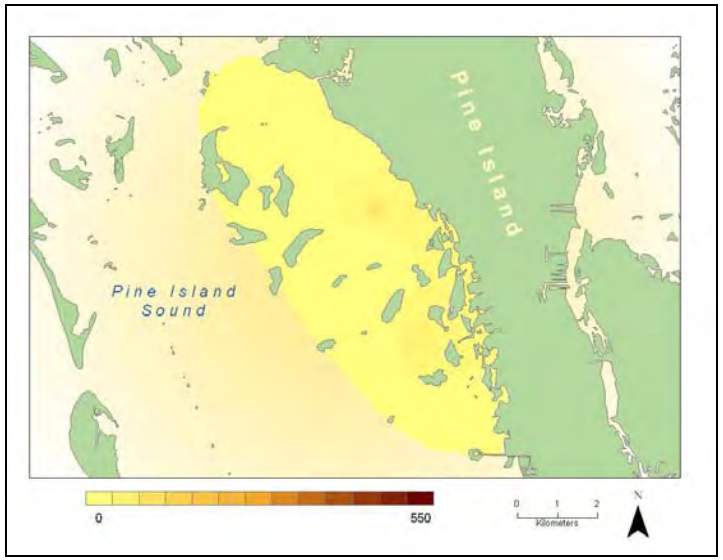
A sequence of maps helps to visualize the temporal changes in scllop distribution from 2003 to 2006 as a result of recent restoration activities in north Pine Island Sound (Figure 3) and south Pine Island Sound. Note the difference in scale between the two figures.

Table 4. Annual mean bay scallop density in Pine Island Sound. Values are mean number of scallops per 600 m^2 from twenty stations. (Data from FWRI annual population surveys).

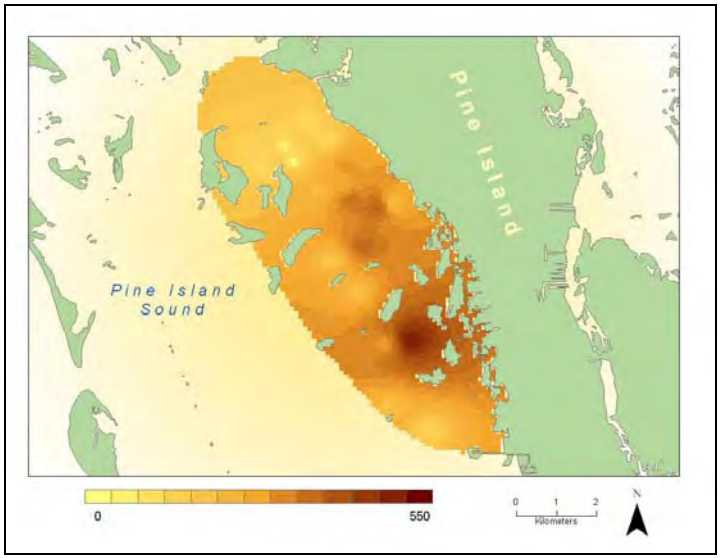
YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
North PIS	0.00	2.5	0.8	2.3	2.4	2.6	2.8	5.5	0.7	0.6	1.1	93.4	8.2
S.D.	0.00	7.69	2.07	3.87	5.66	6.12	5.31	10.47	1.57	1.14	1.85	131.9	9.05
South PIS	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.1	2.4	1.3
S.D.											0.22	5.48	1.86

Table 5. Total number of bay scallops at each station during the June, 2006, adult bay scallop survey. (Data from FWRI annual population surveys).

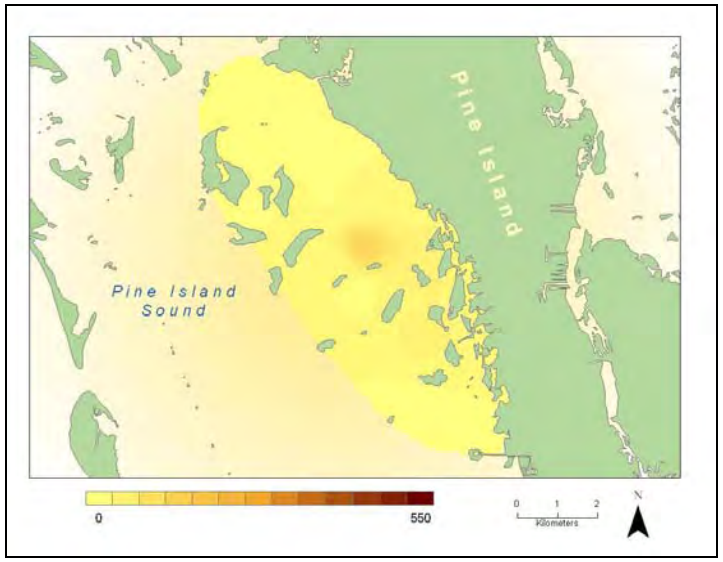
STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL	MEAN	S.D.
North PIS	7	13	7	40	3	1	3	15	4	2	4	2	2	2	9	7	14	0	12	16	163	8.15	9.05
South PIS	0	0	4	0	0	1	0	0	1	0	1	1	1	0	3	0	0	6	3	5	26	1.3	1.86



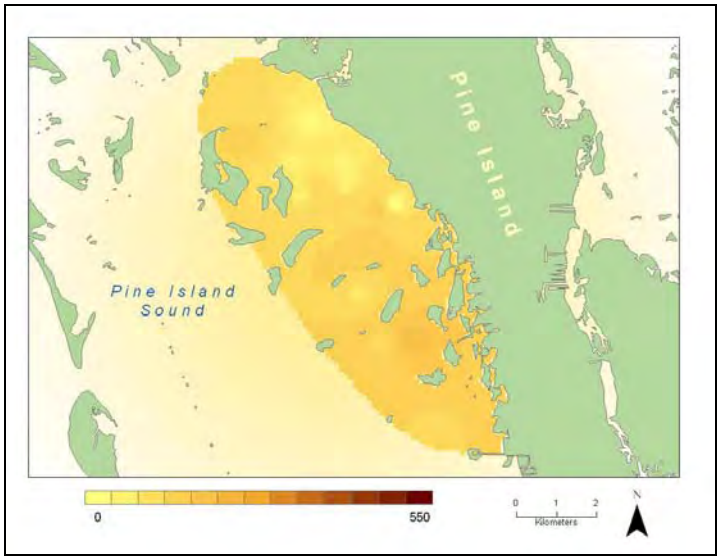
2003



2005

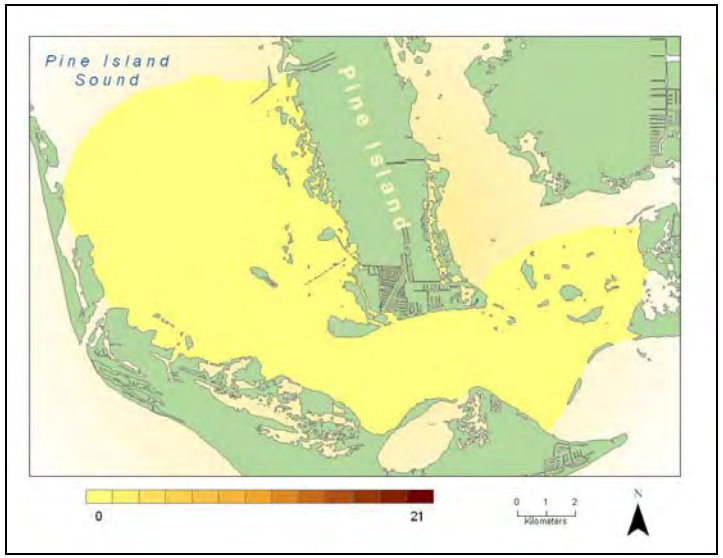


2004

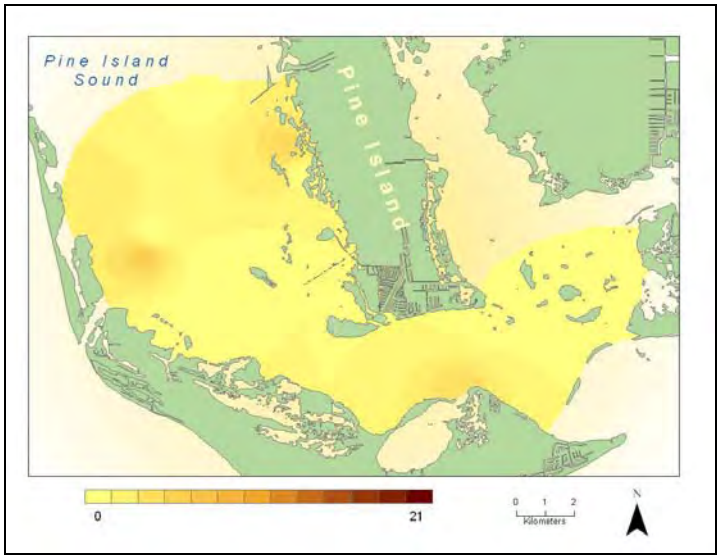


2006

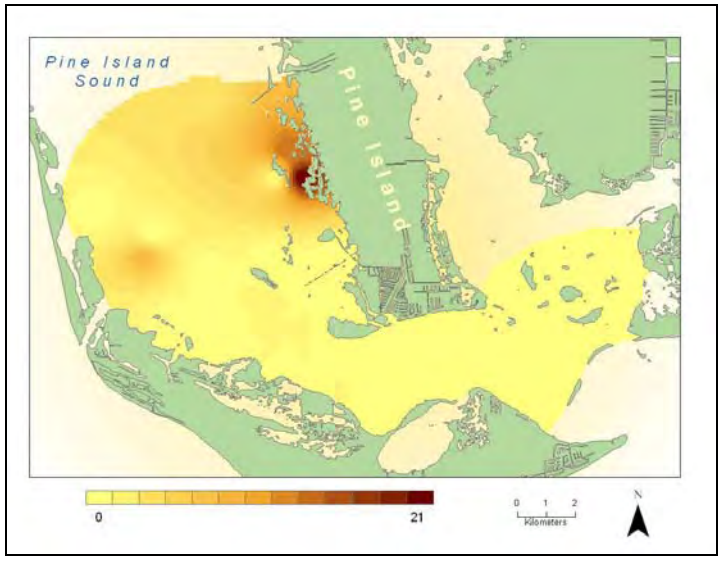
Figure 3. Annual scallop abundance and distribution in north Pine Island Sound from 2003 – 2006. (FWRI).



2004



2006



2005

Figure 4. Annual scallop abundance and distribution in south Pine Island Sound from 2004 – 2006. (FWRI).

SUPPLEMENTAL LARVAL RELEASE

In June, 2006, an additional release of scallop larvae was conducted in south Pine Island Sound to supplement the initial restoration efforts in this region of the Sound. This additional release followed the same protocols for the collection, conditioning and spawning of broodstock, as well as the rearing and transport of larvae as the previous release. The major difference for this release was the elimination of containment booms; thus, this was a "free release" of scallop larvae.

Approximately four million larvae were equally divided and released at four locations (Fig 3). Four standard spat collectors were prepositioned along the four compass points at a distance of 100 meters from each other. Larvae were released within the boundary of the spat collectors by idling the boat in gear and slowly pouring the larvae into the water.

The spat collectors remained in place for six weeks. Afterward, they were retrieved, allowed to dry for several weeks, and then were inspected for juvenile scallops. Spat were retrieved from two of the locations (Sites 2 and 4) (Table 6). At site 2, two collectors were missing at the time of retrieval. No other assessments were made for this additional release in time for this report.

Table 6. Number of spat on collectors from "free release" of scallop larvae. South Pine Island Sound, June, 2006. Collectors were deployed for six weeks.

	Site 1	**Site 2**	**Site 3**	**Site 4**
East	0	1	0	3
South	0	1	0	0
West	0	-----	0	0
North	0	-----	0	3
Total	**0**	**2**	**0**	**6**

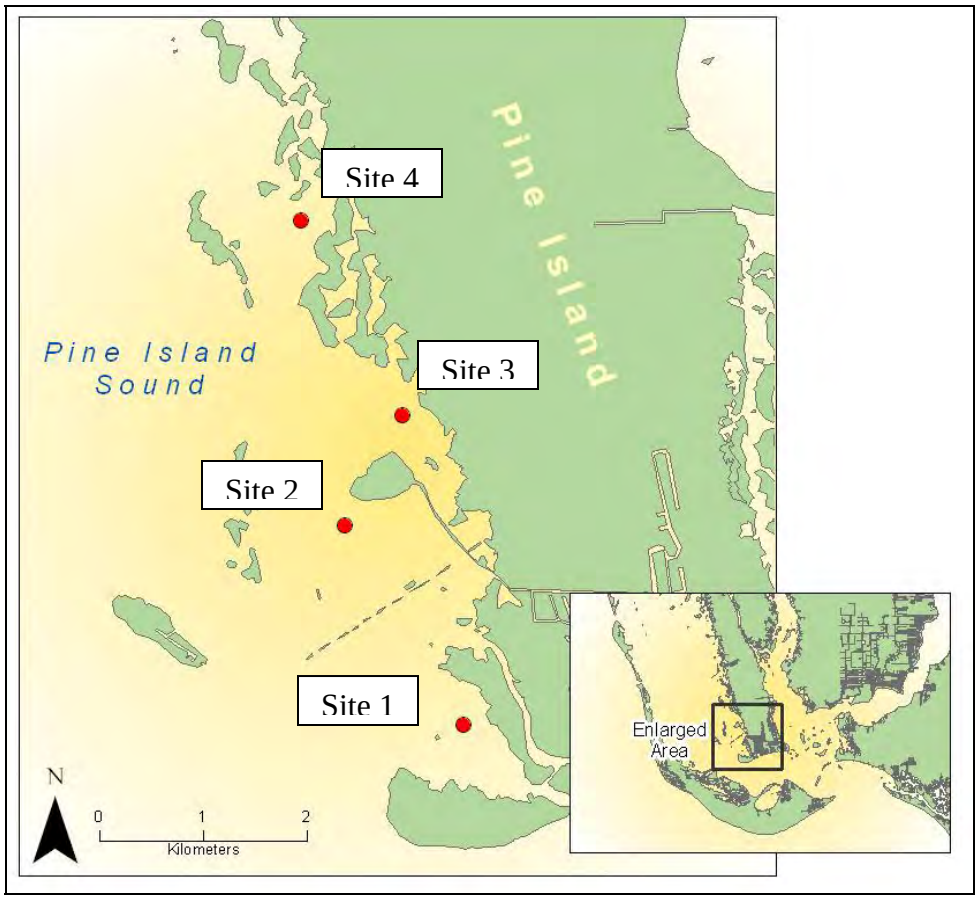


Figure 5. Locations of the four sites for the "free release" of scallop larvae.

DISCUSSION

We have now had three opportunities to enhance bay scallop populations in Pine Island Sound through the controlled release of hatchery-reared larvae. We have seen a dramatic rebound in scallop densities since these activities have begun, especially when compared with the previous ten years of scallop data from the Sound. In 2005, Pine Island Sound had the highest density of scallops of all the Florida estuaries surveyed by FWRI. This included Steinhatchee and St. Joseph's Bay, two regions which have had consistently stable scallop populations and remain open to recreational harvest. Such an immediate and dramatic response in Pine island Sound unquestionably surpassed our collective expectations.

This restoration technique has three major assessment elements to monitor progress and evaluate success. These elements are spat recruitment, juvenile monitoring and adult surveys. Of these, spat monitoring measures the most sensitive aspect of this restoration method. Scallop larvae have to survive, grow and develop in the hatchery, be transported from the hatchery to the field, and must acclimate to field conditions. Metamorphosis from a larva to a juvenile is also very stressful, and unless all of the larvae are very healthy and properly acclimated to changes in water quality from the hatchery to the field, the very real possibility exists for most, if not all, to perish during the process. Despite these potential pitfalls, spat recruitment monitoring from this project demonstrated that a very high number of spat attached to collectors at three of the four target sites, a positive indication that these obstacles were successfully overcome. We feel comfortable in saying that an abundant number of young scallops were likewise able to recruit to the seagrasses at these locations. At the FWS Refuge, however, based on the low number of spat, we cannot say with any certainty what the potential will be for scallop enhancement this year.

During the 2003 restoration project, only eight juvenile scallops were recovered from the treatment containment booms. Surveys from the current project did not find any juvenile scallops at any release site. Based on the combined results from both projects, it does not appear that the number of juveniles, as an interim measurement, is a reliable indicator of restoration success. The reason for this is not clear. One explanation may lay with our methodology, whereby we are not adequately searching a large enough area to arrive at a reasonable estimate of population abundance. If we wish to maintain replication in assessing population abundance, we will probably need to increase the size of our quadrat. However, this may make it more difficult to properly survey for small individuals underwater. A second possibility is that 3-month old juveniles are small enough and cryptic enough (covered with a fine later of sediment and attached to the base of seagrass shoots) that they are below the reasonable detection limit of a human observer. These methodological questions will be addressed in future restoration projects.

A major benefit in undertaking this restoration project in Pine Island Sound is the presence of an historical database on scallop abundance. FWRI has been conducting annual surveys in this area since 1994, and each year they have revisited the same locations and have employed the same methodology. Furthermore, they have conducted identical scallop surveys in eight other Florida Gulf Coast estuaries every year over the same time span. This database has become invaluable in assessing the impacts of our restoration against natural fluctuations in scallop population dynamics in Pine Island Sound and throughout the state.

Against this historical backdrop, it is evident that scallop abundance rebounded in Pine Island Sound over the past several years. From our work, we have discovered that it

takes two years, or annual cycles, for a successful larval release to manifest itself in higher adult abundance throughout the area. After the first year, if all has gone well, we have established what we refer to as a natural "spawner stock" at the center of the restoration site. This spawner stock represents the surviving cohort of larvae that were initially released the previous year and prevented from dispersing because of the containment booms. Figure 3 shows this quite nicely for 2004. This highly concentrated assemblage of scallops in 2004 performed as a spawner stock; when spawning occurred, fertilization success was increased due to the broodstock being in such close proximity to one another. The larvae from this in situ spawn were then free to disperse and settle naturally. Figure 3 shows that there were two "peaks" in adult density in 2005; one occurred at the original restoration site while the other appeared to the south. We speculate that this second area of scallop abundance is due to the prevailing tidal currents and local circulation patterns.

The incredibly high scallop density in 2005 was quite a surprise to all of us. We were therefore not as surprised when densities in 2006 returned to more "reasonable" values. Our initial success criteria for scallop restoration in Pine Island Sound was one order of magnitude increase in scallop abundance. In 2005, we saw abundance increase by two orders of magnitude! In 2006, the average scallop abundance was still close to an order of magnitude higher than recent annual abundance values. Of equal importance in assessing the impact of our efforts was the finding that scallops were present at ninety-five percent of our survey stations. We are beginning to find scallops at locations that have been void of scallops over the past decade. This observed spread in the spatial distribution of scallops should assist in rebuilding local populations toward historical levels. We feel this is valuable information and therefore intend to include spatial distribution as well as abundance measures as evaluation criteria in measuring the success of future scallop restoration projects.

While these results are encouraging, there are plenty of reasons for caution and restraint. The first reason, which may also partially explain why we saw such an immediate response from our efforts, has to do with the natural history of the bay scallop itself. Bay scallops, especially Florida populations, are annual animals, living out their entire life over the span of one year. Individual scallops may vary in their longevity, but the population can be considered to "turnover" roughly every year. Therefore, if there are any significant adverse conditions that the population encounters in a given year, there is a good chance that the entire population may suffer a mass mortality event. If this happens, then rebuilding local populations can only occur through one of three ways: successful spawning and recruitment from surviving scallops, larval transport from distant populations (e.g., the Anclote estuary or Florida Bay), or human intervention. Several stressors that can be reasonably expected to come into play in Pine Island Sound, and to which bay scallops are vulnerable, include: freshwater inputs that reduce salinity to below 20 ppt for extended periods of time, prolonged periods of hypoxia (low dissolved oxygen) and red tide. Pine Island Sound periodically experiences all of these potential stressors.

Freshwater inflow, especially in southern Pine Island Sound/San Carlos Bay, and periodic red tides throughout the Sound are serious impediments to sustaining abundant bay scallop populations over the long term. In 2006, a red tide was present in the Sound throughout most of the summer. On July 14, when Mr. Leverone retrieved the spat collectors from the supplemental larval release , he observed numerous dead fish throughout the release site. Qualitative weekly reports of environmental conditions within the Caloosahatchee River estuary, including freshwater releases, flow, salinity and red tide conditions are

included in Appendix 2. Weekly bottom salinity at Shell Point is shown in Appendix Figure 1. This information is critical in evaluating the potential for successful scallop restoration in this part of the estuary against a background of environmental conditions. While it appears that the salinity stayed above the critical value of 20 ppt at our restoration sites, the area experienced a significant red tide episode, and we suspect that this will have a detrimental impact on our restoration efforts, particularly in the southern portion of the Sound.

As we continue to gain experience from each restoration opportunity and refine our techniques with each release, we now have an option in place to overcome these temporary population crashes once the stressor has been removed. We are currently developing techniques to spawn scallops "out of season" in order to be able to release larvae on our schedule. We have identified unique genetic "markers" to differentiate between scallops produced in the hatchery and "wild" scallops from the field. The more we work in Pine Island Sound, the more familiar we are with areas we think offer the greatest potential for successful restoration. We now have an established team in place; a dedicated shellfish hatchery and an experienced scientific team from highly respected organizations that have perfected this technique through trial and error. We are now better prepared to respond to events and conduct individual or comprehensive scallop restoration than ever before. We appreciate the funding and interest from each of our supporting organizations and for the opportunity to continue this work.

REFERENCES

Leverone, J.R., W.S. Arnold, S.P. Geiger and J. Greenawalt. 2004. Restoration of bay scallop populations in Pine Island Sound: Competent larval release strategy. Mote Marine Laboratory Technical Report #974. 13p.

APPENDIX 1

PROJECT PHOTOGRAPHS

Fig 1. Containment booms opened up prior to field deployment.

Fig 2. Containment boom after field deployment.

Fig 3. Containment boom showing surface floatation and side panel

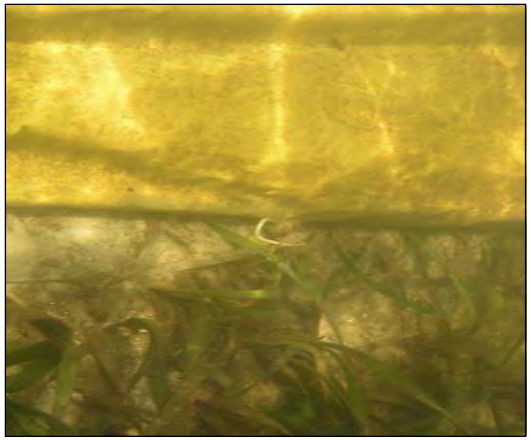


Fig 4. Containment boom showing bottom secured to sediment surface.

Fig 5. Anchors used to secure booms to the sediment. (Note hole for attaching line).

Fig 6. Mr. Leverone releasing scallop larvae into a containment boom.

Fig 7. Recruitment collector including weight and surface buoy

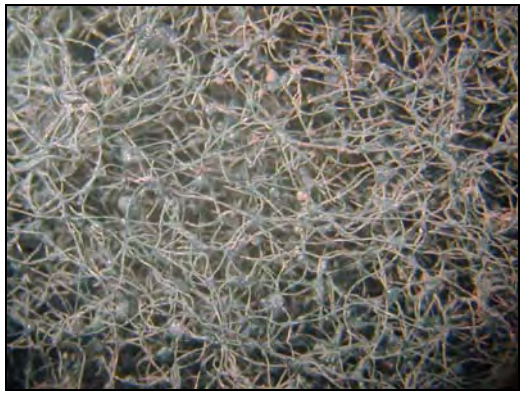


Fig 8. Low-power photomicrograph showing recruitment collector after retrieval, fixation and drying. (Scallop larvae is attached to fiber in middle).

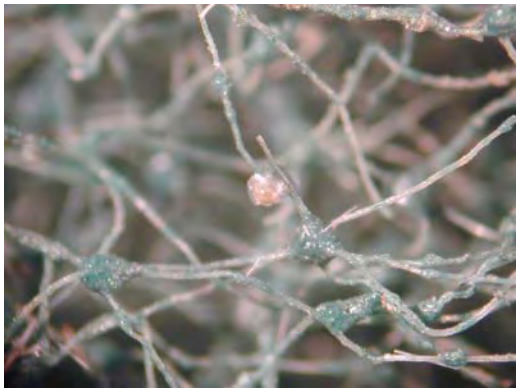


Fig 9. Mid-power photomicrograph showing scallop larvae attached to recruitment collector (same as Fig 8).

Fig 10. High-power photomicrograph showing scallop larvae attached to recruitment collector (same as Fig 8).

APPENDIX 2

CALOOSAHATCHEE RIVER

Weekly Environmental Condition Reports (SFWMD)

Caloosahatchee Estuary

Weekly Environmental Condition Reports (SFWMD)

May 23, 2006

Over the past week discharge at S-79 averaged 879 cfs. The 30-day average discharge is 818 cfs and within the preferred range. Salinity at Ft. Myers averaged 5.4 ppt on the surface and 8.3 ppt on the bottom. Corresponding values at Cape Coral were 16.5 ppt and 18.5 ppt and at Shell Point 27.4 ppt and 28.3 ppt. Salinity conditions are good.

June 6, 2006

A pulse release (averaging 800 cfs over 10 days) began on June 3. Over the past week discharge at S-79 averaged 431 cfs, with 72 % accounted for by releases from Lake Okeechobee (S-77 = 309 cfs). Salinity has increased in the estuary over the past week. At S-79 salinity averaged 3 ppt . At Ft Myers salinity averaged 10.1 ppt on the surface and 11.7 on the bottom. The 30-day average surface salinity is 6.8 ppt. Shell Point salinity averaged 28 ppt. Salinity conditions are good.

Some water quality measurements were made at selected stations on May 22. Dissolved oxygen was well above levels of concern ranging from 7.3 – 9.9 mg/l. Secchi disk depths were good, ranging from 0.8 m in the upper estuary to 2.55 m in the lower estuary and San Carlos Bay.

June 13, 2006

A modified level 1 pulse release which began on June 3, 2006 continued this week. Over the past week discharge averaged 761 cfs at S-79 and 670 cfs at S-77 with 88% accounted for by releases from Lake Okeechobee. The 30-day average discharge at S-79 is 576 cfs and within the preferred range. The average weekly salinity in the estuary has remained relatively constant since last week. At Ft. Myers salinity averaged 9.8 at the surface and 10.7 at the bottom. The 30-day average surface salinity is 7.9 ppt. At Cape Coral surface salinity averaged 18.5 ppt over the past week. Salinity at Shell Point averaged 28 ppt. Salinity conditions are good.

June 19, 2006

A pulse release (averaging 800 cfs over 10 days) began on June 14. Over the past week discharge at S-79 averaged 739 cfs, with 91 % accounted for by releases from Lake Okeechobee (S-77 = 670 cfs). The 30-day average discharge at S-79 is 630 cfs and within the preferred range. Salt may be found throughout the estuary. Salinity at S-79 averaged 1.8 ppt over the past week. In Ft. Myers salinity averaged 8.7 ppt on the surface and 10.2 ppt on the bottom. The 30-day average surface salinity increased over the past week to 8.7 ppt. At Shell Point weekly salinity averaged 28 ppt. Salinity conditions in the estuary are good.

June 26, 2006

Discharge at S-79 averaged 260 cfs over the past week with 100 % accounted for by releases from Lake Okeechobee (S-77=625 cfs). The 30-day average discharge at S-79 is 514 cfs and within the preferred range. Salt may be found throughout the estuary. Salinity at S-79 averaged 3 ppt over the past week. Tape grass beds in the upper estuary between Ft. Myers and the I-75 Bridge have experienced weekly average salinities in the 3 to 8 ppt range and within established tolerance limits. The 30-day average salinity at Ft. Myers is 9.1 ppt. At Shell Point salinity averaged 25 ppt. Salinity conditions are good.

July 5, 2006

Discharge at S-79 averaged 1017 cfs over the past week (S-77=Not Reporting). The 30-day average discharge at S-79 is 715 cfs and within the preferred range. Salinity at S-79 averaged 2 ppt. Tape grass beds in the upper estuary between Ft. Myers and the I-75 Bridge have experienced weekly average salinities in the 3 to 8 ppt range and within established tolerance limits. The 30-day average salinity at Ft. Myers is 8.56 ppt. At Shell Point salinity averaged 25 ppt. Salinity conditions are good.

July 11, 2006

From July 5 through the 10th, discharge at S-79 averaged 702 cfs. S-77 is still not reporting. The 30-day average discharge at S-79 is 755 cfs and within the preferred range. Above normal rainfall in the Ft. Myers area during the last week has also contributed freshwater to the estuary. The 30-day average salinity at Ft. Myers is 7.5 ppt. On Sunday (7/9/05), average surface salinity was down to 3.6 ppt at the Ft. Myers sensor. Tape grass beds in the upper estuary between the I-75 Bridge and Ft. Myers have experienced average salinities from 1.7 ppt to 5.2 ppt during the last week, which is within the preferred range. At the Cape Coral Bridge, salinity averaged 11 ppt and at Shell Point the salinity averaged 22 ppt. In general, salinity in the estuary is good, with concentrations continuing to slowly trend downward.

July 18, 2006

Discharge at S-79 averaged 1287 cfs over the past week. The 30-day average discharge at S-79 is 812 cfs and within the preferred range. Freshwater extends at least to the I-75 Bridge. Tape grass beds in the upper estuary between Ft. Myers and the I-75 Bridge have experienced weekly average salinities in the 0 to 2.3 ppt range and within established tolerance limits. The 30-day average salinity at Ft. Myers is 5.7 ppt. At Shell Point salinity averaged 19.0 ppt and 20.2 ppt on the bottom. Salinity conditions are good. Blue green algae have been reported both in the C-43 Canal and in the downstream estuary. The most recent survey conducted by District contractors (7/5/06) reported that blue green algae were visible in water samples down to Marker 27 near Beautiful Island. A red tide continues in San Carlos Bay and Pine Island Sound.

July 25, 2006

Discharge at S-79 has increased during the previous week, averaging 1565 cfs. There is no discharge coming from Lake Okeechobee through S-77. The 30-day average discharge at S-79 is now 1035 cfs and remains within the preferred range. Southwest

Florida last week again received above normal rainfall, with 5-7" in the Ft. Myers area to 10" in San Carlos Bay. Therefore, local tidal basin runoff is presumed high, adding considerable amount of freshwater downstream of S-79 and lowering salinity more than expected. As of yesterday, freshwater currently extends to Ft Myers, which includes the tape grass beds located upstream. The 30-day average salinity at Ft. Myers is down to 4.4 ppt. At the Cape Coral Bridge, yesterday's salinity was 4.1 - 4.4 ppt and below the preferred range. Shell Point salinity yesterday averaged 14.4 ppt on the surface and 16.0 ppt on the bottom, which indicates salinity in eastern San Carlos Bay is being influenced. In general, salinity conditions in the estuary are fair. Red tide conditions continue to persist since the end of June and intensify in Pine Island Sound. At the end of last week, both NOAA and FWRI reported patchy moderate to high impacts in San Carlos Bay and Pine Island Sound regions of Lee County. Observations of algae have also been reported in the Cape Coral canals. Medium to high impacts are correlated with respiratory irritation, discolored water, and fish kills: all of which have been reported in the region. Therefore, even though environmental conditions upstream are good for tape grass, environmental conditions are poor downstream.

August 1, 2006

Discharge at S-79 averaged 945 cfs over the past week. The 30-day average discharge at S-79 is 1115 cfs and within the preferred range. Freshwater extends downstream to Ft. Myers. Tape grass beds in the upper estuary have experienced weekly average salinities < 1.0 ppt and within established tolerance limits. Weekly average salinity at Cape Coral (Surface= 3.8 ppt, Bottom = 4.6 ppt) and Shell Point (Surface= 14.1 ppt, Bottom = 16.3 ppt) are relatively low. These data suggest that oysters near the Cape Coral Bridge and seagrass in eastern San Carlos Bay are stressed by low salinity. Salinity conditions in the upper estuary are good but fair in the lower estuary and San Carlos Bay. Newspapers report blue green algae in the Caloosahatchee as far downstream as Fort Myers and red tide along the Collier County coast. The Florida Wildlife Research Institute reported highest concentrations of red tide in Charlotte and Lee Counties.

August 8, 2006

Discharge at S-79 averaged 468 cfs over the past week. The 30-day average discharge at S-79 is 1086 cfs and within the preferred range. Freshwater extends downstream to the I-75 Bridge. Tape grass beds in the upper estuary have experienced weekly average salinities ranging from 0 – 2.1 ppt and within established tolerance limits. Weekly average salinity at Cape Coral (Surface= 5.5 ppt, Bottom = 9 ppt) and Shell Point (Surface= 18.1 ppt, Bottom = 19.5 ppt) increased during the past week. Salinity conditions are good. Blue green algae have been reported in the C-43 Canal. FWRI reports that a bloom of the Florida red tide organism continues to impact the southwest Florida coast this week. Fish kills and respiratory irritation are possible between southern Sarasota County and northern Collier County.

August 15, 2006

Discharge at S-79 averaged 362 cfs over the past week. The 30-day average discharge at S-79 is 912 cfs and within the preferred range. Freshwater extends

downstream to the I-75 Bridge. Tape grass beds in the upper estuary have experienced weekly average salinities ranging from 0 – 4.0 ppt and within established tolerance limits. Weekly average salinity at Cape Coral (Surface= 10.2 ppt, Bottom = 12.2 ppt) and Shell Point (23 ppt) increased during the past week. Salinity conditions are good. The Florida Wildlife research Institute reports that areas of Lee County, including Pine Island Sound, have seen a decrease in red tide (*K. brevis*) concentrations since last week. A somewhat stationary bloom patch of low concentrations remains present along the Collier County coast.

August 22, 2006

Discharge at S-79 averaged 1143 cfs over the past week. The 30-day average discharge at S-79 is 857 cfs and within the preferred range. Salinity in Ft. Myers averaged 4.22 ppt on the surface and 6.34 ppt on the bottom. The 30-day average at the surface sensor is 2.2 ppt. Salinity at Shell Point averaged 23 ppt. Salinity conditions in the estuary and San Carlos Bay are good. The Florida Wildlife Research Institute reports patchy red tide from Boca Grande Pass south to Naples with mostly low concentrations detected.

August 29, 2006

Discharge at S-79 averaged 4838 cfs over the past week. The 30-day average discharge at S-79 is 1640 cfs and within the preferred range. Tape grass beds in the upper estuary between the I-75 Bridge and Ft. Myers have experienced salinities in the 0-2.4 ppt range during the past week. These values are within established tolerance limits. The 30-day average at the surface sensor in Ft Myers is 2.5 ppt. Salinity at Shell Point averaged 20.1 ppt on the surface and 21.3 on the bottom. Salinity conditions in the estuary and San Carlos Bay are good. The Florida Wildlife Research Institute reports that *Karenia brevis*, the Florida red tide organism, was detected at medium to high concentrations alongshore from Anna Maria Island (Manatee County) to Captiva Pass (Lee County).

September 5, 2006

Salinity in the Caloosahatchee estuary decreased precipitously between August 30 and 31. Since 8/31, discharge at S-79 averaged 16,100 cfs with 100% being accounted for by basin runoff (S-77= 0 cfs). The 30-day average discharge at S-79 is 4290 cfs and outside the preferred range. Freshwater extends at least to the Cape Coral Bridge. Since 8/31/06, salinity at Shell Point averaged 2.8 ppt on the surface and 7.5 on the bottom. Salinity conditions in the lower estuary and San Carlos Bay are poor.

September 12, 2006

Discharge at S-79 averaged 8271 cfs over the past week with 100% being accounted for by basin runoff (S-77= 0 cfs). The 30-day average discharge at S-79 is 6578 cfs and outside the preferred range. Freshwater extends at least to the Cape Coral Bridge. Shell Point averaged 4.9 ppt on the surface and 6.5 on the bottom. Salinity conditions in the lower estuary and San Carlos Bay are poor. FWRI reports that red tide may cause respiratory irritation and fish kills between southern Pinellas County and northern Collier County.

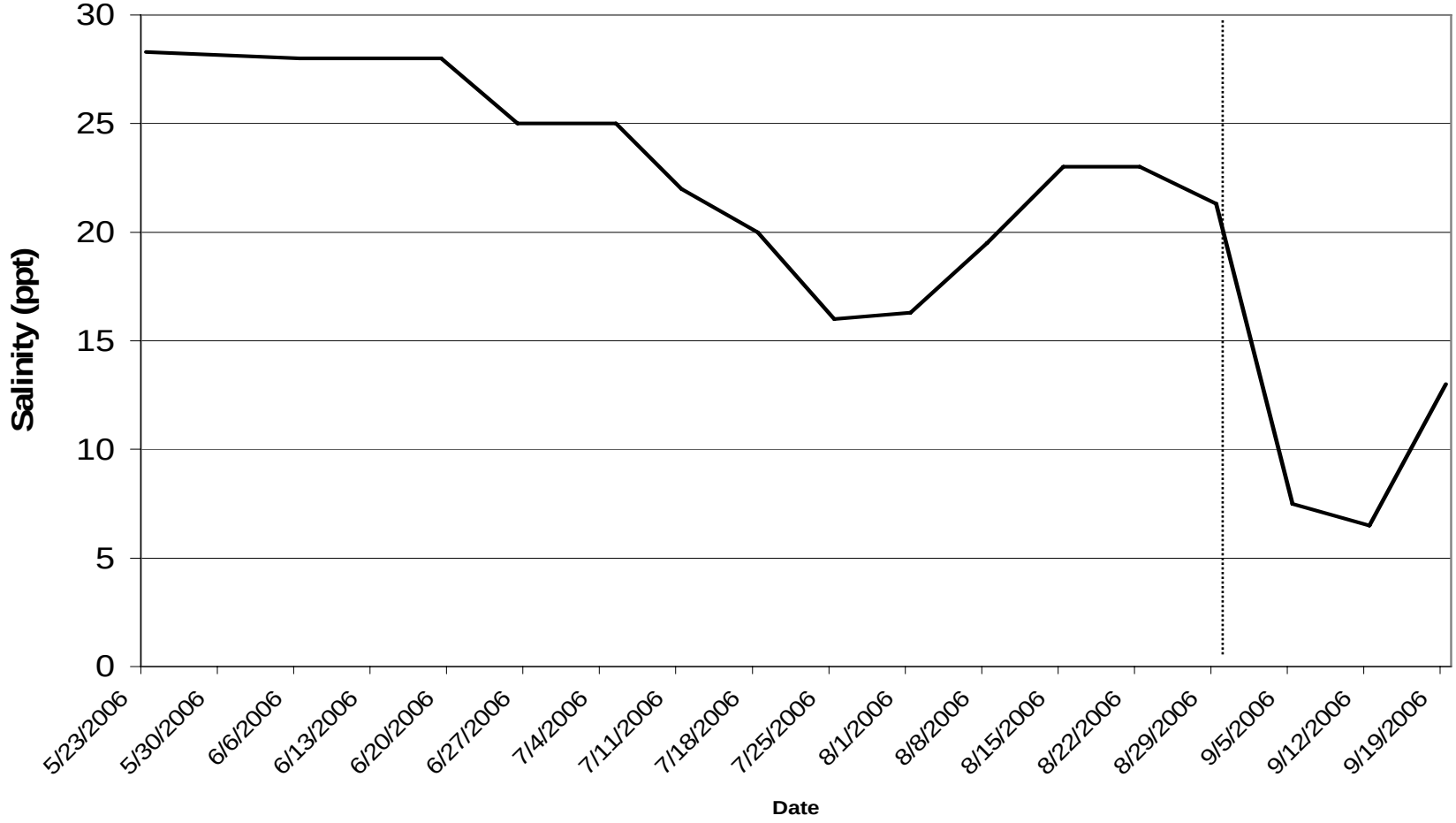
September 19, 2006

Discharge at S-79 declined over the past week averaging 3911 cfs with 100% being accounted for by basin runoff (S-77= 0 cfs). Salinity increased slightly over the past week. Surface waters are fresh down to the Cape Coral Bridge. However, some salt is detectible (~ 1 ppt) in bottom waters at this site. Salinity at Shell Point averaged 8.5 ppt on the surface and 13.0 on the bottom. Salinity conditions remain poor in the lower estuary and San Carlos Bay. FWRI reports that concentrations of red tide range from not present to high along the shore in Charlotte, Lee and Collier Counties including areas of Gasparilla and Pine Island Sounds. Fish kills and respiratory irritation are possible between northern Pinellas County and Collier County.

September 26, 2006

Discharge at S-79 declined over the past week averaging 2170 cfs with 100% being accounted for by basin runoff (S-77= 0 cfs). The 30 day average discharge is 7226 cfs. Salinity increased slightly over the past week. Surface waters are fresh down to the Cape Coral Bridge. However, some salt is detectible (~ 1 ppt) in bottom waters at this site. Salinity at Shell Point averaged 11.3 ppt on the surface and 14.9 on the bottom. Salinity conditions remain poor in the lower estuary and San Carlos Bay.

FWRI reports that patchy red tide conditions remain in Charlotte and Lee counties, including areas of Gasparilla Sound and Pine Island Sound, where *K. brevis* concentrations ranged from not present to high. Fish kills and respiratory irritation are possible between northern Pinellas County and Collier County.



Appendix Figure 1. Mean weakly salinity at Shell Point during the time frame of this restoration project. Bay scallops require prolonged salinities over 20 ppt for survival (dashed line).