A dual approach for examining growth rates in the eastern oyster (*Crassostrea virginica*) within three southwestern Florida estuaries

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INTRODUCTION

Many environmental decision and policy makers in Florida face a rather unique dilemma, that being the issue of water. While Florida seemingly has abundance, its location and amount are very often disputed. In one such case, the enormous 113,000 acre Southern Golden Gate Estates housing development project, which began in the very early 1960's by the Gulf American Corporation, now stands as a hulking, incomplete and nearly abandoned monument to earlier, unsound water management practices. Normal sheet flow within this wetland mosaic has been grossly altered via an extensive grid-like series of canals. These highly efficient conduits rapidly funnel up to 411 million gallons of fresh water daily from the previously unwrinkled landscape (The Conservancy Update, 1997). Through an intensive lot buy-back program, however, some 55,000 acres of the development has now been scheduled for restoration in the near future (Proposed Plan For Hydrologic Restoration, 1997).

It is generally thought that such abnormal influxes of fresh water pollution channeled directly into the estuary system, which lays southwest of the project, has had adverse effects on at least some members of its biotic community. Up to this point, few scientific base line data have been established or is available in this area and reclamation and restoration managers are anxious for information regarding what the overall health of their project should resemble when completed.

The use of indicator organisms for detecting modification in ecosystems has been successfully used in aquatic environments (Osenberg, 1994). While estuarine ecosystems may contain profuse and complex trophic webs, one particular organism appears to be an excellent index species candidate. Because of their benthic, sessile, suspended phytoplankton feeding nature the eastern oyster, *Crassostrea virginica*, may prove an especially valuable tool for determining overall health in tidally influenced areas.

The importance and purpose of this study, therefore, is an attempt to quantify possible variations of settlement location by larval oysters between the modified Faka-Union system and other nearby unaltered estuarine settings. Additionally, long-term growth rate comparisons will also be conducted by employing two distinct techniques.

METHODS

In order to accurately investigate comparable growth rates of eastern oysters, specially designed devices were manufactured and placed within three separate southwestern Florida estuary locations. Additionally, various sized clusters of oysters were collected, transported to a marine laboratory facility, treated in a tetracycline solution and returned to their original locations. Tracking of new oyster settlement and accretion rates, as well as periodical harvesting and examination of treated specimens from within all three estuaries, will provide quantifiable data regarding overall growth trends within each of the systems under investigation. Any significant differentiation, should there be one, may then be apparent.

The overlying experimental design employs a spatial homologue approach (Savarese, 1997). That is, because all three of the estuaries display profoundly similar pre-transformation geomorphologies, corresponding points along the axis of each should display analogous water qualities, and therefore similar faunal representations. Consequently, should water flow alteration be of no consequence, it can be expected that *C. virginica* in all three systems studied will display very comparable growth-trend characteristics. Inconsistencies with the above would suggest that alteration of the natural hydrologic flow may actually have consequential significance.

During the month of June 1999, eighteen oyster recruitment platforms were constructed and deployed. Later in that same month, oyster clumps were gathered and treated with the marker-producing agent, tetracycline (Pirker and Shiel, 1993). Two corresponding homologue sites were selected along each of the three estuaries (Fig. 1). Blackwater River is used as the control location since anthropogenic impact is generally considered to be negligible along this waterway. Henderson Creek, though narrowly

manipulated via a small water control device (WCD) several kilometers upstream, will also be used to provide supplementary data. Faka-Union, with its diversionary flow, shall serve as the study sector.

Salinity data for all three tidally influenced areas were gathered and plotted for 1996 via remote sensing telemetry stations positioned within each estuary. Readings reveal critical divergence during the rainy season, June through October (Fig. 2). Inner bay readings were collected more landward, while outer bay data were gathered closer to the Gulf. The two undiminished systems, Henderson Creek and Blackwater River, track each other quite closely while the dredged, Faka-Union waterway system displays a distinct divergence from the others.

Oyster recruitment platforms. A total of eighteen identically constructed replicate platforms were fabricated from PVC piping and fittings, and transparent, 6mm x .5m square acrylic sheeting. Nylon fasteners were employed to secure the platform top to the lower anchoring assembly. Entire assemblages were constructed of corrosion resistant materials; no metal parts were used in the fabrication process. Each fifty square centimeter sheet was mechanically etched into a ten square centimeter grid system. Additionally, a threaded, detachable joint was incorporated between the acrylic top and the anchoring post to facilitate removal for examination without needing to extract the entire anchor post assembly. In order to orient the “top edge”,

each sheet was drilled with a hole numbering system and color coded, plastic wire ties were inserted and fastened.
Three replicates were positioned per individual test site location in order to encourage settlement of pediveligers, the early, free-swimming stage of an oyster's existence. After spending approximately 14 days in this vulnerable, planktonic condition, generally a clean, hard-surfaced site is sought out for permanent attachment (Carriker, 1986). The settling size of pediveligers is quite small, only about one third of a millimeter. Once attachment occurs, the minute juveniles are commonly referred to as spat. Routine monitoring and recording of individual spat settlement dates and distinct platform location will be tracked throughout the study. With accurate dates of settlement established via regular tracking, an authentic measure of development rates within each estuary complex may be achieved.

Tetracycline banding. Throughout their lifetime, oysters continually lay down internal growth rings that can be useful for determining life span (Kirby, et al. 1998, Clark, 1974). A second technique being employed to characterize oyster progress within the three estuarine systems involves a banding procedure utilizing tetracycline hydrochloride to induce a time marker tag.

When subjected to a tetracycline bath, components of the chemical compound are incorporated within the oyster's calcium carbonate shell material. When examined postmortem, a highly visible luminous green band in the hinge portion of the shell appears under UV light. By producing this time marker, a known "start date" can be established to compare developmental patterns in the animals, regardless of individual proportions or age when initially treated (Fig. 3).

During the second half of June 1999, clumps of oysters were randomly selected and gathered from the immediate vicinity where each of the recruitment platforms had been previously stationed. Clusters were carefully transported back to the Rookery Bay laboratory and treated in a tetracycline hydrochloride solution of 80 mg/L estuarine water for thirty-six hours. Approximately 150-200 individual oysters were treated per location. Aquaria containing the oyster clusters were aerated and the water continuously circulated. Following treatment, clusters were again carefully transported to their original locations where they are continuing to mature.

Each of the returned clusters of treated oysters was securely knotted and tethered to a common hub using two- meter lengths of fifty-pound test monofilament line. A central post driven approximately one meter deep into the sediment serves as the axis from which all of the attached lines emanate in a spoke-like manner. The PVC post also facilitates relocation. Periodic harvesting and examination of individuals will be conducted throughout the project in order to compare post-treatment accretion rates.

RESULTS AND DISCUSSION

A pre-deployment test of the tetracycline banding technique proved to be highly successful. A total of twenty-four individual oysters were exposed to the bathing methodology. All specimens exhibited a permanent, distinguishable green band which, when exposed to UV light, appeared in the most recently laid segment of the oyster's ligament pit.

Because the banding portion of this experiment appears, thus far, to be somewhat unique for examining *C. virginica*, substantial contributory data have been gained in this area alone. While results from the treated and returned specimens are yet to be defined, the above preliminary results offer encouragement for success when individuals are eventually harvested. Growth comparisons, and therefore a determination concerning overall comparative health, may then be postulated.

Oyster recruitment platforms have been revisited at all six estuary locations. Oysters at various stages of development were detected on all platforms with the exception of one study site. Inspection of the site one platforms on the upper Faka-Union waterway revealed no evidence of settlement. Platform-settled juveniles were, however, found in small numbers at study site two further down stream. The Blackwater and Henderson Creek platforms at both study sites are presently displaying as many as thirty newly settled individuals per structure.

Mature specimens of *C. virginica* require salinities above 10% and temperatures above 20 ºC to initiate spawning (Galtsoff, 1964). Due to the relatively late season initiation of this project, more time will be necessary, a complete seasonal cycle, perhaps, before more conclusive results may be obtained. It is worthwhile noting, however, that the lack of spat settlement at test area one on the Faka-Union waterway tends to support my initial hypothesis: that large influxes of freshwater pollution may be modifying the biotic community within the Faka-Union system. As the waters again begin to warm with the approaching spring months, spawning activities should become much more accelerated. Expectations, therefore, are for increased numbers of larval oysters to establish themselves on the platforms throughout that approaching cycle. Monitoring efforts will continue in the coming months.

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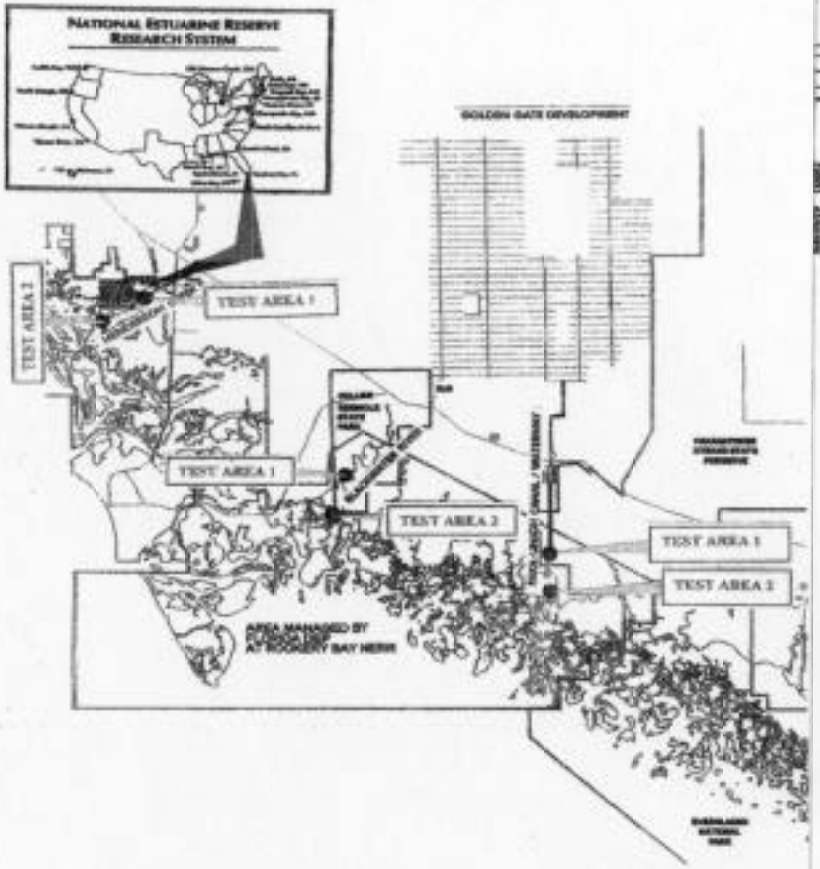

Figure 1. Map of the Ten Thousand Islands regionin southwestern Florida. Approximate locations of test sites are indicated: Henderson Creek located in the upper left quadrant, Blackwater Creek in the central portion, and Faka-Union in the lower right quadrant. Grid section in upper center indicates Southern Golden Gate Estates extensive canal system and its subsequent drainage southwesterly into the Faka-Union waterway.

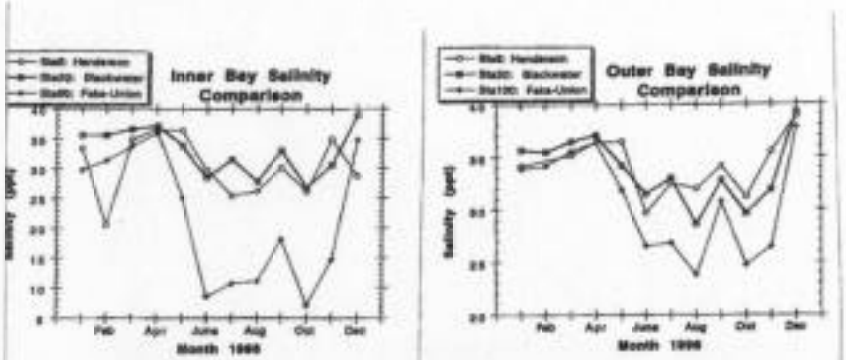

Figure 2. Salinity data gathered and plotted for 1996 via remote sneising telemetry stations positioned within each estuary reveals significant deviation during the rainy season, June through October. The two unaltered systems, Henderson and Blackwater, track each other rigorously. The dredged Faka-Union system exhibits a visible departure.

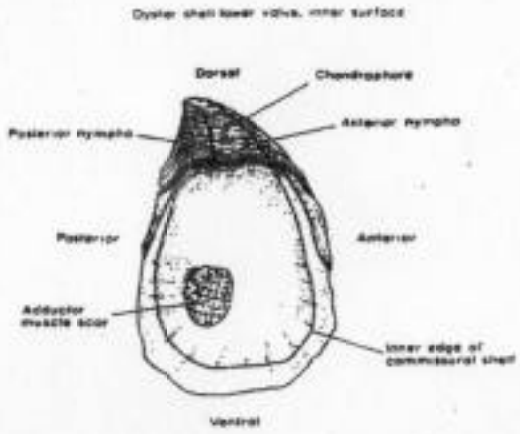

Figure 3. Oyster shell, *Crassostrea virginica*, nomenclature. Tetracycline treated specimens display a distinguishing green ridge which becomes readily visible when exposed to a UV light source. Thin, dark shaded line located at the lower edge of the posterior nympha represents location of the green banding marker following treatment.