An Annotated Bibliography of Research/Data Collection Conducted within the Estero Bay Watershed Since 1999

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Introduction. The purpose of this effort is to update the available information concerning research that has been conducted and published about Estero Bay and its watershed. Estevez (1981) conducted the first literature survey for the greater Charlotte Harbor watershed (including Estero Bay), followed by PBS&J and W. Dexter and Associates, Inc. (1999) and PBS&J (1999), the latter of whom focus on Estero Bay in particular. These publications contain much valuable information and data, and possibly can assist in "reconstructing" baseline (or benchmark) criteria to compare against future studies. A review of these publications indicates that the bibliography for Estero Bay extends to 1998; therefore the efforts here begin with 1999. An attempt was made to only include publications with pertinent information regarding Estero Bay; i.e., documents with passing mention of the bay were omitted.

Bibliography

Charlotte Harbor National Estuary Program. 1999. Data management, analysis, and exchange strategy. 79 pp. This document describes data management strategy for the Charlotte Harbor National Estuary Program. It identifies data gaps and needs, and suggests actions to fill information gaps and encourage data exchange. It includes information on web sites, geographical information systems, CD-ROM data, newsletters and reports.

Johnson Engineering. 1999. South Lee County watershed plan. Contract C-8812 prepared for the South Florida Water Management District, West Palm Beach, FL. This is a comprehensive water management plan for the South County area aimed at restoring historic surface water flow characteristics, improving water detention and aquifer recharge potential, reducing the threats of saltwater intrusion, and other problems related to the watershed of the area. Phase 1 describes the hydrologic-hydraulic model development. Phase 2 is an ecological assessment. Phase 3 addresses watershed problems and plan formulation.

Kurz, R.C. 1999. Summary of recent trends in seagrass distributions in southwest Florida coastal waters. Southwest Florida Water Management District, Technical Report. The report of a study initiated to assess seagrass coverage in the Tampa Bay, Sarasota Bay, Lemon Bay, and Charlotte Harbor estuaries and to monitor the effects of improvements in water quality on seagrass beds expansion. Maps, charts, tables of data, and a brief bibliography are included.

Mitchell-Tapping, H. J., et al. 1999-2008. Research studies in Estero Bay Aquatic Preserve, Lee County Florida. Fort Myers Beach, FL: Estero Bay Marine Laboratory. This series consists of yearly progress reports of baywatch research studies of Estero Bay, Florida. The primary objective is to acquire data, interpret, and characterize the water quality within the Estero Bay watershed. A secondary goal is to determine temporal trends and problems within the bay, to identify probable causes, and to make an integrated description of the health of the bay. Research has focused on dissolved oxygen concentrations over seagrass meadows, plankton abundance and composition, red mangrove crab abundance, and other topics.

Estero Bay Agency on Bay Management. 2000. State of the Bay. This 61-page report provides a general description of the bay, its tributaries, and its watershed including geology, history, land use and development, and educational/recreational/tourist activities. There are also general descriptions of population growth in the watershed, water quality, biota, and bay/watershed habitats. Issues of special concern are presented, including impacts of 10-Mile Canal; areas built prior to 1975 (do not have to meet SFWMD criteria for water quality or quantity), outstanding Florida waters, environmentally sensitive lands, listed species, exotic animals and plants, flooding (1995), offshore oil drilling, use of bay waters, waterfront and shoreline development, backbay fishing, and changes in hydrodynamics. Agencies with interest in Estero Bay are listed, and various maps are provided (land use, drainage, etc.).

Mitchell-Tapping, H.J. and J.P. Mellon. 2000. Seagrass sediment particle-size and content in Estero Bay, Southwest Florida. Conference, AAPG Gulf Coast Section (GCAGS), Houston, TX, Oct. 25-27, 2000. AAPG Bulletin 84(10): pp.1686. Grain size and content analyses was made of the top 3 in. of sediment from 33 cores taken across 3 species-specific seagrass beds in Estero Bay Aquatic Preserve, southwestern Florida during 1999. There was a significantly higher content of silt in *Thalassia* and *Thalassia-Halodule* mix sediments than in *Halodule* beds, possibly due to differences in wave-energy and freshwater run-off.

W. Dexter Bender & Associates, Inc. 2000. Charlotte Harbor National Estuary Program: Long Term Monitoring Strategy and Gap Analysis. The Comprehensive Conservation Management Plan (CCMP) is the major product of the planning phase of a National Estuary Program. Summarized findings of the management conference are described and include the identification and prioritization of priority problems, environmental goals and quantifiable objectives, as well as action plans with schedules for resource management. These efforts are to protect valued uses of the greater watershed. As priority actions are accepted by agencies as complementary tasks related to their missions and responsibilities, specific monitoring strategies, gaps and points assessments for examining existing management practices are needed. One of the first steps in the Charlotte Harbor NEP planning phase was to canvas the existing monitoring programs. A summary of the existing monitoring programs was published in October 1997. This report is the initial basis for determining where monitoring gaps exist and identifying which programs might contribute to the implementation phase of the CCMP. In establishing an overall monitoring strategy, the Charlotte Harbor NEP formally established seven goals on which to base the various aspects of the overall program: 1) Improve the environmental integrity of the Charlotte Harbor study area; 2) preserve, restore, and enhance seagrass beds, coastal wetlands, barrier beaches, and functionally related uplands; 3) reduce point and non-point sources of pollution to attain desired uses of the estuary; 4) provide the proper freshwater inflow to the estuary to ensure a balanced and productive ecosystem; 5) develop and implement a strategy for public participation and education; 6) develop and implement a formal Charlotte Harbor management plan with a specified structure and process for achieving goals for the estuary; and 7) develop an accessible information management system that integrates data on the Charlotte Harbor study area pertinent to Harbor and watershed management. The priority problems were hydrology, water quality, and fish, wildlife, and flora. The report outlines suggested sampling strategies, experimental design, methodologies, and data analyses to address these topics, noting that the strategy will be similar to EPA EMAP efforts. Data gaps are also noted briefly, and an appendix of data analytical techniques is included.

Dabbs, C.G. 2001. Estero Bay watershed integrated groundwater/surface water hydrologic model. Geological Society of America, Southeastern Section, 50th Annual Meeting, Raleigh, NC, United States, April 5-6, 2001. Geological Society of America, 33(2): pp. 17. This presentation outlines a model to estimate the hydrologic impacts of the rapid growth of the Estero Bay area during the past decades with its increased population and accompanying urban and agricultural development, which has stimulated significant concerns regarding the water and environmental resources of the region. There is concern that the scale of urban and agricultural development will affect the ecological integrity of the region, as well as the environmentally sensitive Corkscrew Audubon sanctuary within the watershed.

Jones, R.D., and J.N. Boyer. 2001. Integrated surface water quality monitoring program for the south Florida coastal waters: FY2000 cumulative report to the South Florida Water Management District (C-10244), and Everglades National Park. 55 pp. Miami, FL: Southeast Environmental Research Center, Florida International University. Covers Cape Romano to Pine Island Sound (including Estero Bay), providing site-specific information on salinity, temperature, dissolved oxygen, turbidity, total nitrogen and total phosphorous, total organic nitrogen, total organic carbon, alkaline phosphatase activity, chlorophyll a, silicate, nitrate, nitrite, ammonium, total phosphorous and soluble reactive phosphate.

Swett, R.A., Fann, D.A., Antonini, G.A., and L.C. Alexander. 2001. Regional Waterway Management System for Lee County, Phases 1 & 2. Gainesville, FL: State University System of Florida, Sea Grant College Program. The project aims to devise a management strategy that allows for the simultaneous use and protection of coastal waters, while maintaining the economic vitality of the region.

Florida Marine Research Institute. 2002. Reported nesting activity of the Loggerhead Turtle in Florida, 1993-2001. Florida Fish and Wildlife Conservation Commission, St. Petersburg, Fl. Tables of data reporting locations of Loggerhead Turtle (*Caretta caretta*), Green Turtle (*Chelonia mydas*), Leatherback Turtle (*Dermochelys coriacea*), Hawksbill Turtle (*Eretmochelys imbricata*), and Kemps Ridley (*Lepidochelys kempii*) nesting sites in Florida from 1993 through 2001. For each location cited, data is also provided indicating the beach length, year, number of days per week, survey start date, survey end date, first nest date, last nest date, number of non-nesting emergences, and the number of nests. The survey covers Bay, Brevard, Broward, Charlotte, Collier, Duvall, Escambia, Franklin, Gulf, Hillsborough, Indian River, Lee, Manatee, Martin, Miami-Dade, Monroe, Nassau, Okaloosa, Palm Beach, Pinellas, Santa Rosa, Sarasota, St. John's, St. Lucie, Volusia, and Walton counties.

Hansen, M., and G. Perry. 2003. Estero Bay to Charlotte Harbor bathymetric survey USGS Final Report contract C-13105-WO01 submitted to the South Florida Water Management District. Available from the South Florida Water Management District, Lower West Coast Service Center, Fort Myers, FL.

Janicki Environmental, Inc. 2003. Water quality data analysis and report for the Charlotte Harbor National Estuary Program. Available from the Charlotte Harbor National Estuary Program, Fort Myers, FL. The goal of this project was to compile data sets for surface and ground water quality, hydrology, and rainfall; conduct analyses of temporal variations (changes and trends); and conduct analyses of existing water quality conditions in the study area. The results of the rainfall analyses indicated that there were essentially no overall trends in rainfall for the rainfall data period of record (approximately 1950's to 2000) or for the period of record for which water quality trends were tested (approximately 1980's to 2000). Over the course of the water quality record (1996-2000), dissolved oxygen decreased at several Estero Bay stations, turbidity increased, and fecal coliform levels decreased. Nitrate concentrations increased, as did total suspended solids, but at a lower rate than other portions of the greater Charlotte Harbor region. Compared with other stations in the greater Charlotte Harbor region, the estuarine stations in Estero Bay were ranked high for turbidity, conductivity, and salinity, and were ranked among the lowest compared to other basins for nitrogen species, phosphorous species, fecal coliform bacteria, and BOD. The secchi depth of 0.95 m was ranked among the estuarine stations having the poorest light penetration. The Estero Bay stream stations were ranked as having among the highest chlorophyll and BOD values, and the lowest turbidity, DO, ammonia and phosphorous values. Estero Bay was judged to have an acceptable fecal coliform condition, and unacceptable dissolved oxygen and ammonia conditions. The stations in the Estero Bay Basin frequently exceeded the three sets of nutrient criteria for chlorophyll, nitrogen, phosphorous, and Secchi disk depth.

NOAA Coastal Services Center. 2003. Benthic habitat mapping, Estero Bay, Florida. Charleston, SC (http://www.csc.noaa.gov/benthic/data/gulf/estero.htm). This is a benthic habitat

map that has now been linked up with the FWRI Marine Resources GIS webpage: http://ocean.floridamarine.org/mrgis/viewer.htm.

Cassani, J.R. 2004. A preliminary evaluation of chlorophyll-a concentrations in the Estero Bay watershed: 2002-2003. Chlorophyll-a annual averages were summarized with respect to all of Lee County's Estero Bay Watershed sampling stations and on a seasonal and monthly basis for 2002 and 2003. It is apparent from this summary that impairment thresholds for chlorophyll-a are being exceeded in all of the secondary watersheds similar to what was determined from the impaired waters (TMDL) assessment made by Florida DEP in 2002 from data through 2001. It is, however, beyond the scope of this assessment to estimate impairment based on all data per WBID. A hierarchy of nutrient loading hot spots was determined from sampling locations having chlorophyll-a values frequently exceeding 20 ug/l. Sampling stations with a relatively high frequency of chlorophyll-a values exceeding 20 ug/l were: HENDGR30 (Hendry Creek), 10MIGR91 (10 Mile Canal), SIXMILE5&1 (Six Mile Slough), 48-10&15GR (Spring Creek). The sub watersheds associated with these stations should be examined for land uses or other activities that may be contributing excessive nutrient loads. An examination of seasonal and monthly chlorophyll-a values indicate an unexpected "spike" during the dry season at a significant number of sampling stations. A closer examination of this pattern is warranted to effectively target nutrient reduction BMPs.

Dawes, C. 2004. Drift algae in the Charlotte Harbor area. Report to the South Florida Water Management District. During the winter of 2003-2004, large masses of drift red macroalgae (Division Rhodophyta) accumulated on the beaches of Sanibel Island and then in southern Charlotte Harbor, San Carlos Bay, and Estero Bay. The dominant species identified were the red algae *Chondria atropurpurea, Gracilaria caudata, Hypnea spinella,* and *Soleria filiformis* all being common as attached and drift seaweeds in Florida. Based on previous studies, the last three of species are known to have broad tolerances to light, temperature, and salinity and occur in both estuarine and offshore populations. A number of earlier studies have documented drift algae in the Indian River Lagoon on the east coast of Florida and in Crystal Bay, the Anclote Anchorage, Tampa Bay, Boca Ciega Bay, and Tarpon Bay on the west coast. Comparison of species shows that the dominant ones are similar in all studies and included species of red algal genera (Division Rhodophyta) that also occur in southern Charlotte Harbor, namely *Gracilaria Hypnea, Chondria, Acanthophora,* and *Laurencia.*

Estero Bay Agency on Bay Management. 2004. State of the Bay – Trends and Analysis. This 69-page report begins with a description of the Agency on Bay Management, including its founding and purpose. Tables on 2001 water quality status were presented, in which copper, fecal coliform, dissolved oxygen, and chlorophyll-a were in violation of water quality standards at some (but not all) stations. Several stations were also noted for having elevated levels of total nitrogen and phosphorus. Individual station data are also presented for the various parameters comparing 2001 peak and mean values to previous years (back to 1989 in some cases). Data are also presented for wildlife, fish landings, population, and recreational activities.

Lee County Master Mitigation Plan. 2004. The Mitigation Plan has three main purposes: 1. to provide a master strategy by which critical environmental features continue to be preserved, 2. to provide "safe harbor" approaches for mitigation projects that are required for the infrastructure needed to accommodate growth, which in turn will enable the budgeting process to be reliable, and 3. to restore degraded resources that are important for the health, safety, and welfare of the public. This plan outlines various projects that can affect the Estero Bay watershed including road extensions and widening (loss of forest and/or wetland), flood control measures, and nutrient control measures (e.g., filtering marshes). The current status of these projects is unknown.

Madley, K., Krolick, J., and B. Sargent. 2004. Assessment of boat propeller scar damage within the Greater Charlotte Harbor Region. This study compared prop scarring of seagrass habitats between 1993 and 2003. Results indicate that the amount of seagrass habitat that has been affected by propeller scarring has increased 38% from 1993 to 2003. The amount of severely scarred seagrass habitat has increased 71%, while the amount of lightly scarred seagrass has declined 50%. Examinations of prop scar prevalence indicate areas around docks, marinas, channel edges, oyster bars, and mangrove islands are exceptionally susceptible to repeat scarring. These are areas that draw vessels on repeat trips and often over very shallow water. Between 1993 and 2004, Estero Bay had a 95% and 72% decrease in light and moderate prop scarring respectively, but an increase of 490% in severe prop scarring. Presumably, the decrease in lightly and moderately scarred areas results from habitats that were classified as light/moderate scarring in the previous study that are now contained within the areas classified as severely scarred.

Conservancy of Southwest Florida. 2005. Estuaries Report Card for Southwest Florida. Estero Bay received an overall wildlife habitat grade of C-, due to a low amount of wetlands remaining (50%) and low amount of conservation land acreage (22%). Estero Bay received a final water pollution grade of D, and an overall water quality grade of D-. These low grades were due to low dissolved oxygen values, high fecal coliform, nutrient, and copper concentrations. Additional loss of grade was due to hydrologic alterations made in the bay and its watershed, resulting in high flows during the wet season, and low/no flow in the dry season. The overall wildlife habitat and water quality grades were D-.

Tolley, S.G., Volety, A.K., and M. Savarese. 2005. Influence of salinity on the habitat use of oyster reefs in three southwest Florida estuaries. Journal of Shellfish Research 24:127-137. Lift nets containing oyster clusters were deployed along a salinity gradient at three sites within each of three estuaries (Caloosahatchee, Estero Bay, and Faka-Union Bay) to determine how salinity influenced the habitat value of oyster reefs on seasonal and spatial scales. Oyster densities and

other community metrics (other organism densities, diversity, biomass, etc.) were determined. Several metrics increased downstream in one or more systems (organism density, biomass, diversity) and seemed to relate better to changing salinity rather than oyster densities. Organism densities were higher during the wet season, but biomass was greater during the dry season in the Caloosahatchee. Diversity tended to be higher in Estero Bay and the Caloosahatchee during the dry season as well. These results suggest that salinity requirements of oyster reef-inhabiting organisms should be considered when planning oyster reef restoration projects and managing freshwater flows.

Corbett, C.A. 2006. Numeric water quality targets for Lemon Bay, Charlotte Harbor, and Estero Bay, Florida. Charlotte Harbor National Estuary Program Technical Report 06-3. This document expands/updates the study reported in Corbett and Hale (2006). In response to documented seagrass loss and declining water quality (clarity) within the CHNEP region, this study set out to establish water quality targets for color, turbidity and chlorophyll *a* specific to each estuarine segment that encompasses the greater Charlotte Harbor estuarine complex including Lemon and Estero Bays. Percent-light-at-depth targets required to achieve seagrass maximum depth distribution were determined in each segment. An optical model, describing total light attenuation as the sum of three partial light attenuation components: color, chlorophyll *a* and non-algal suspended solids was then applied. Seasonal water quality data for each estuary segment were plotted with the intercepts overlaid, producing a plane of constant attenuation giving the percent-light-at-depth goal. It is this plane of constant attenuation that is our proposed target. These water quality targets will be used by resource managers and NEP partners to hold the line on water quality in the greater Charlotte Harbor estuary, especially those parameters influencing water clarity and seagrass coverage.

Corbett, C.A. 2006. Seagrass coverage changes in Charlotte Harbor, Fl. Florida Scientist 69: 7-23. Seagrass areal coverage was estimated through seagrass polygon maps for 1982–2003 for Upper and Lower Charlotte Harbor regions and 13 seagrass segments. Analyses did not detect trends in Upper or Lower Charlotte Harbor regions from 1982–2003. Estero Bay data were excluded from much of the analysis due to a lack of comparable data, although decreasing trends noted in other studies coupled with water quality concerns were acknowledged.

Corbett, C.A., and J.A. Hale. 2006. Development of water quality targets for Charlotte Harbor, Florida using seagrass light requirements. Florida Scientist 69:36-50. Water quality data were collected throughout the preserve (including Estero Bay) during both wet and dry seasons. The data were analyzed to determine the minimum light-at-depth requirements needed to support seagrass growth and maintenance. While the criteria were generally met during the dry season, in many cases, the criteria were not met during wet season. The authors conclude that this study is a good first step towards establishing resource-based water quality criteria for the region.

Estero Bay Agency on Bay Management. 2006. State of the Bay. A power point presentation illustrating water quality trends in the bay and some aspects of land development (loss of cypress and flatwood forests due to development) and ecological impacts (local extinction of the Florida scrub jay around Estero Bay). The primary water quality parameters of concern were fecal coliform in Hendry and Mullock Creeks; ammonium in Mullock Creek (San Carlos Park area), nitrate/nitrite from Mullock Creek down to the Imperial River; orthophosphate from Mullock Creek to the Estero River; and dissolved oxygen (everywhere). Seagrass losses were documented primarily in the northern section of the bay near Hendry Creek, and turbidity, chlorophyll-a levels, and water color were parameters of concern, as were cases of prop-wash resuspension. Some watershed actions were suggested to improve water quality (e.g., buy more lands, reduce fertilizer use, etc.).

Lapointe, B.E., Bedford, B., Brand, L., and C.S. Yentsch. 2006. Phase II Final Report: Harmful Algal Blooms in Coastal Waters of Lee County, FL: Bloom Dynamics and Identification of Land-Based Nutrient Sources. Report presented to Lee County. This report summarizes results of the 2005 sampling efforts to study drift algae and harmful microalgal blooms in the coastal waters of Lee County, including Estero Bay. The report presents evidence of nutrient enrichment in terms of low C:N and low C:P ratios, high $\delta^{15}N$ ratios from various algal samples suggesting a sewage-source for nitrogen, and evidence of light limitation on macroalgae during the year.

Ott, J.A., Duffey, R.M., Erickson, S.E., Fuhr, K.S., Rodgers, B.A., and M.A. Schneider. 2006. Comparison of light limiting water quality factors in six Florida aquatic preserves. Florida Scientist 69:73-91. Correlations of secchi depth to color, turbidity and chlorophyll-a within and between eight estuaries comprising the Charlotte Harbor estuarine complex were examined. Six years (1998–2004) of monthly water quality data from the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network were examined. Significant correlations were found between secchi depth and the combination of color, turbidity and chlorophyll-a in six of the estuaries, explaining 26% to 53% of secchi depth change. Color was the strongest predictor of secchi depth in 6 estuaries and turbidity was the greatest predictor in two of the estuaries. Estero Bay had secchi readings, turbidity values, water color values, and chlorophyll-a concentrations worse than the top 30% of the healthiest estuaries in Florida as reported in Hand (2004). Turbidity was the best indicator of secchi depth in Estero Bay.

Tolley, S.G., Winstead, J.T., Haynes, L., and A.K. Volety. 2006. Influence of salinity on prevalence of the parasite *Loxothylacus panopaei* in the xanthid *Panopeus obesus* in SW Florida. Diseases of Aquatic Organisms 70:243-250. This study was conducted to examine the potential influence of salinity, a proxy for freshwater inflow, on the prevalence of the castrator parasite *Loxothylacus panopaei* on saltmarsh mud crabs *Panopeus obesus* on SW Florida oyster reefs. Spatial and seasonal patterns of the presence of potential host crabs and the prevalence of the parasite were assessed in the Caloosahatchee, Estero, and Faka Union estuaries. Lift nets containing oyster clusters were deployed on intertidal reefs at 3 sites along the salinity gradient of each estuary. Nets were deployed during 3 seasonally dry and 3 seasonally wet months for a period of 30 d. *P. obesus* densities tended to increase downstream in higher salinity waters, with crabs being absent from the upper station in the Caloosahatchee during both seasons and absent from the upper station of the Faka Union during wet months. Parasite prevalence was reduced upstream in each estuary during wet months compared to dry months, and for those estuaries that experienced higher relative levels of freshwater inflow. Furthermore, parasite prevalence was positively correlated with the mean salinity of capture of host crabs. Based on the distribution of *P. obesus* and the above patterns related to salinity, it appears that freshwater inflow and seasonal rains might regulate the prevalence of this parasite in SW Florida by creating spatiotemporal, low salinity refuges for its host.

Tolley, S.G., Volety, A.K., Savarese, M., Walls, L.D., Linardich, C., and E.M. Everham. 2006. Impacts of salinity and freshwater inflow on oyster-reef communities in Southwest Florida. Aquatic Living Resources 19:371-387. The influence of salinity on the spatial and temporal variability of oyster reef-associated communities was assessed using multivariate techniques to analyze decapod crustacean and fish abundance data. Organisms were collected at three reefs along the salinity gradient of three estuaries: the Caloosahatchee River and estuary, Estero River and Bay, and Faka Union Canal and Bay. Additional collections were made from reefs located near the mouths of Estero Bay's five tidal tributaries. Samples were dominated by the decapods *Eurypanopeus depressus* and *Petrolisthes armatus*. Commonly occurring species included the decapods *Panopeus obesus*, *Alpheus heterochaelis* and *Rhithropanopeus harrisii* and the fishes *Gobiosoma robustum*, *Lophogobius cyprinoides* and *Gobiesox strumosus*. Analysis of similarities suggested differences among stations located along the salinity gradients of all three estuaries. Community structure also varied among stations located near the mouths of the tidal tributaries of Estero Bay. Multidimensional scaling identified community structure present at upper stations as distinct from that downstream and at high-flow tributaries as distinct from that near low-flow tributaries. Upper stations and stations near high-flow tributaries were typified by *E. depressus* and gobiid fishes. Downstream stations and stations near low-flow tributaries were typified by *E. depressus* and *P. armatus*. Percent dissimilarity was greatest when upper and lower stations were compared along the salinity gradient or when low salinity and high-salinity sites were compared among tributaries. Within-station sample variability tended to be higher upstream or in association with high-flow tributaries.

Boyer, J.N., and H.O. Briceño. 2007. 2007 Cumulative Annual Report for the Coastal Water Quality Monitoring Network (Agreement 4600000352) for the period January – December 2007. Submitted to the Environmental Resource Assessment Department, Water Quality Analysis Division, South Florida Water Management District, West Palm Beach, FL, by the Southeast Environmental Research Center, Florida International University, Miami, FL. Water quality sampling in Estero Bay for the year 2007 yielding the following results. Salinity was relatively invariant during 2007 and did not show the usual decline during the wet season. Temperature, TON, TP, and TOC were unremarkable as compared to long term median. DO was slightly elevated while pH was higher than normal in the spring/summer. Turbidity, NO_3^-, TOC, and chl-a were generally lower than usual, especially during the wet season. Peaks in chl-a sometimes corresponded with peaks in TP and NH_4^+. TP was higher in the first 8 months and then declined to below the average. NH_4^+ was highly variable and did not seem to be driven by freshwater inputs.

Charlotte Harbor National Estuary Program. 2007. Benthic Invertebrate Species Richness and Diversity at Different Habitats in the Greater Charlotte Harbor System. Mote Marine Laboratory Technical Report No. 1169. Various locations throughout the Greater Charlotte Harbor System were studied. For Estero Bay, eight stations were sampled representing eight different habitats: intertidal mud flat; intertidal sand bar; subtidal mud flat; subtidal sand bar; mangrove; marsh; submerged aquatic vegetation; and oyster reef. Temperature, salinity, dissolved oxygen, pH, and Eh measurements were made, and sediment moisture content and grain size analyses were conducted. A list of invertebrate species, their abundance, and diversity for each of the eight sites is provided as well as comparisons with the other locations.

Division of Aquaculture. 2007. Final Report: Aquaculture Coordination and Monitoring. DEP Agreement Number CZ370; FDACS Contract Number 011898. The Division completed the six tasks as contractually required by this grant: 1) established a grant steering group consisting of the Aquaculture Interagency Coordination Council members and the five Water Management Districts, 2) held 11 agency aquaculture Best Management Practice outreach workshops focused on Aquatic Preserves and National Estuarine Research Reserves, 3) held four aquaculture industry workshops to report the agency workshop results and solicit farmer perspectives regarding working in Aquatic Preserves, 4) produced a technical bulletin describing the value and importance of the Aquatic Preserves to marine aquaculturists and how they might interact with Preserve staff, and 6) completed a water quality monitoring technology review. The review of water quality monitoring instruments is useful in that it compares techniques, deployments, and instruments used to collect data in the various aquatic preserves, including Estero Bay.

Duffey, R., Leary, R.E., and J. Ott. 2007. Charlotte Harbor and Estero Bay Aquatic Preserves Water Quality Status & Trends for 1998 – 2005. Final Report for the Florida Department of Environmental Protection, Charlotte Harbor Aquatic Preserves Office, Punta Gorda, FL. This report presents water quality status and trends from the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN) from 1998 through 2005 across the five Charlotte Harbor Aquatic Preserves (CHAPs) and the Estero Bay Aquatic Preserve (EBAP). Eleven water quality parameters were measured across forty eight sites grouped into nine estuary regions characterized by homogenous hydrologic conditions. These water quality parameters reflect and affect the health and sustainability of the Charlotte Harbor estuaries. Water quality in Estero Bay ranked moderately compared to other estuary regions in the study region, with median values ranging from below to above typical Florida estuarine water quality values. Estero Bay had the highest turbidity levels in the region, with a median value of 4.2 NTU, ranking in the 60th percentile of Florida's estuaries. The DO value was below average compared to typical Florida estuaries and was frequently observed below the Florida Surface Waters Standards of 4.0 and 5.0 mg/L. The pH, temperature and salinity levels significantly decreased over the study period, with significant increases in secchi depth and color concentrations over the eight-year period.

Janicki Environmental, Inc. 2007. Water quality data analysis and report for the Charlotte Harbor National Estuary Program, July 27, 2007. Available from the Charlotte Harbor National Estuary Program, Fort Myers, FL. The goal of this project was to compile data sets for surface and ground water quality, hydrology, and rainfall; conduct analyses of temporal variations (changes and trends); and conduct analyses of existing water quality conditions in the study area. Data were extended up through 2005. The following results were noted for Estero Bay. The annual 1-day and 30-day flow maxima appeared to be increasing, coincident with decreases in the number of low flow pulses. For Estero Bay no steep increasing trends were found. A steep decreasing trend was found at eleven stations for conductivity (possibly reflecting higher stream discharge). Shallow increasing and decreasing trends were found for multiple parameters including ammonium, biological oxygen demand, chlorophyll a, color, conductivity, dissolved oxygen, dissolved silica, enterococci bacteria, fecal coliform bacteria, nitrate, orthophosphate, salinity, total suspended solids, temperature, total nitrogen, total organic carbon, total phosphorus, turbidity, and pH at numerous stations. For Estero River no steep increasing or decreasing trends were found. Shallow increasing trends were found for many parameters (ammonium, conductivity, dissolved silica, nitrate, nitrite, orthophosphate, total suspended solids, total kjeldahl nitrogen, and turbidity). Shallow decreasing trends were found for color, total suspended solids and pH at three or less stations. For Hendry Creek no steep increasing or decreasing trends were found. Shallow increasing trend were found for many parameters (ammonium, dissolved silica, nitrate, orthophosphate, total suspended solids, total kjeldahl nitrogen, total nitrogen and turbidity) at two or less stations for each parameter. Decreasing trends were found (chlorophyll a, color, dissolved oxygen, dissolved silica, and pH) at two or less stations for each parameter. For Imperial River, no steep increasing or decreasing trends were found. Shallow increasing trends were found for ammonium, fecal coliform bacteria, nitrate, nitrite and turbidity at two or less stations for each parameter. Decreasing trends were found for chlorophyll a, color, dissolved oxygen, enterococci bacteria, total suspended solids, temperature, and pH at three or less stations for each station. For Spring Creek no steep increasing or decreasing trends were found. Shallow increasing trends were found in surface waters for many parameters (ammonium, biological oxygen demand, conductivity, dissolved silica, fecal coliform, nitrate, nitrite, orthophosphate, total kjeldahl nitrogen, total nitrogen and turbidity) at three or less stations for each parameter. Shallow decreasing trends were found in surface water for color at three stations. Dissolved oxygen, enterococci bacteria, total suspended solids, and turbidity showed a shallow decrease at one station each. For Ten Mile Canal no steep increasing or decreasing trends were found. A shallow increasing trend was found for ammonium at eight stations in surface waters. biological oxygen demand had a shallow increasing trend at five stations in surface waters. Surface water concentrations of dissolved oxygen, dissolved silica, enterococci bacteria, nitrite plus nitrate, total nitrogen, and pH all had shallow increasing trends at two stations or less for each parameter. Fecal coliform bacteria, orthophosphate and total suspended solids had shallow increasing trends at eight, six, and five stations respectively in surface water stations. Turbidity had a shallow increasing trend at eleven stations. Shallow decreasing trends at two or less stations were found in surface waters for biological oxygen demand, chlorophyll a, conductivity, dissolved silica, orthophosphate, total kjeldahl nitrogen, total nitrogen, and turbidity. Shallow decreasing trends for color, dissolved oxygen, temperature, and pH were found at seven, five, eleven and five stations respectively.

Stearns, C., Ott, J., and J. Greenawalt-Boswell. 2007. Seagrass Annual Data Summary from the Charlotte Harbor & Estero Bay Aquatic Preserves Seagrass Transect Monitoring Program 1999-2006. Florida Department of Environmental Protection, Charlotte Harbor Aquatic Preserves. Five seagrass sites have been monitored within Estero Bay since 2003. At each site, a “transect” is established along a fixed line from the shallow, shoreward edge of the seagrasses to the deep, waterward edge. Transect lengths vary from approximately 10 to 600 meters throughout the study areas depending on bathymetry and water clarity. At regular intervals along each transect, detailed information such as seagrass species, abundance, and density is collected using a one square meter “quadrat”. In addition to these regular intervals, data on the beginning and end of the grass bed is collected on an annual basis. All sites were monitored biannually, in the dormant (February) and growing season (August). Seven specific questions were addressed in this summary, including: 1) How frequently does each seagrass species occur (including no cover*)?; 2) How are the 3 most common seagrass species distributed (including no cover*)?; 3) What is the TOTAL abundance of all seagrass species combined?; 4) What is the abundance of the 3 most common seagrass species?; 5) How dense are the 3 most common seagrass species?; 6) What is the maximum depth of seagrass growth?; and 7) How heavy are the epiphytes on the 3 most common seagrass species? For each question, a subset of analyses were used including: Comparison of Years; Comparison of Regions; and Comparison of Years by Region. Figures and tables were provided to address each question, but no interpretation or discussion was given.

Tolley, S.G., Peebles, E.B., Burghart, S.E., Bachelor, B., Evans, J., and J. Nelson. 2007. Freshwater inflow and utilization of the estuarine tributaries of Estero Bay. Report to the South Florida Water Management District, 227 pp. To investigate the influence of freshwater inflow on zooplankton distribution and density in Estero Bay, 500-micron mesh plankton nets were towed monthly through the water column on a flood tide. Sampling was conducted at 16 stations over a period of two years. Decapods dominated the catch, comprising 87% of the total by number. Ichthyoplankton represented only 4% of the total catch by number but were more diverse than either decapods or gelatinous zooplankton, with 48 species being present. Gelatinous zooplankton were the least diverse of zooplankton groups but comprised 9% of the total catch. The estuarine zooplankton of Estero Bay are strongly influenced by two sources of freshwater inflow: Mullock Creek/Tenmile Canal to the north, and the Imperial River to the south. These influences were apparent in zooplankton distribution and density, which demonstrated an association with one or more tributaries during reduced inflow and became dispersed into downstream open waters of the bay during higher inflow. One management objective should be to keep gelatinous predators (ctenophores, hydromedusae, jellyfishes) out of estuarine tributaries that serve as nursery habitat for estuarine-dependent fishes. In these confined tributary waters, gelatinous predators compete with young fish for prey and may even consume the young fish directly. It appears that relatively small amounts of inflow are effective in dispersing these predators into downstream areas.

Byrne, M.J., and J.N. Gabaldon. 2008. Hydrodynamic Characteristics and Salinity Patterns in Estero Bay, Lee County, Florida: U.S. Geological Survey Scientific Investigations Report 2007-5217, 33 p. Continuous stage and salinity data were recorded at eight gaging stations in Estero Bay estuary from October 2001 to September 2005. Continuous water velocity data were recorded at six of these stations for the purpose of measuring discharge. In addition, turbidity data were recorded at four stations, suspended sediment concentrations were measured at three stations, and wind measurements were taken at one station. Salinity surveys, within and around Estero Bay, were conducted 15 times from July 2002 to January 2004. The average daily discharge ranged from 35,000 to -34,000 ft3/s (cubic feet per second) at Big Carlos Pass, 10,800 to -11,200 ft3/s at Matanzas Pass, 2,200 to -2,900 ft3/s at Big Hickory Pass, 680 to -700 ft3/s at Mullock Creek, 330 to -370 ft3/s at Estero River, and 190 to -180 ft3/s at Imperial River. Flood tide is expressed as negative discharge and ebb flow as positive discharge. Reduced salinity at Matanzas Pass was negatively correlated (R^2 = 0.48) to freshwater discharge from the Caloosahatchee River at Franklin Locks (S-79). Matanzas Pass is hydrologically linked to Hell Peckney Bay; therefore, water-quality problems associated with the Caloosahatchee River also affect Hell Peckney Bay. Rocky Bay was significantly less saline than Coconut Point and Matanzas Pass was significantly less saline than Ostego Bay, based on data from the salinity surveys. The quality-checked and edited continuous data and the salinity maps have been compiled and are stored on the U.S. Geological Survey South Florida Information Access (SOFIA) website *(http://sofia.usgs.gov).*

Charlotte Harbor National Estuary Program. 2008. Comprehensive Conservation and Management Plan (CCMP). This plan provides background information about the Charlotte Harbor National Estuary Program and the greater Charlotte Harbor watershed. It focuses on the following priority problems: hydrologic alteration; water quality degradation; fish and wildlife habitat loss, and stewardship gaps. There is also mention of a SFWMD report entitled "*Nutrient*

Load Assessment for the Estero Bay and Caloosahatchee River Watersheds" although no such report was found.

Van Horn, J., and S.G. Tolley. In Press. Patterns of Distribution Along a Salinity Gradient in the Flatback Mud Crab, *Eurypanopeus depressus.* Gulf of Mexico Science. *Eurypanopeus depressus* were collected from three stations along a salinity gradient in each of three estuaries to measure the effect of salinity on the spatial and temporal distributions of this crab. An analysis of abundance showed that although this species can survive extreme salinities, it is most common in moderate environments. Biomass is also highest at moderate salinities, though mean size is larger at low saIinities. Few significant differences in these metrics between seasons were observed. These results suggest that although *E. depressus* is little affected by normal seasonal changes in salinity, salinity does play a role in their distribution.

Publications that were reviewed but not included in the annotated bibliography due to the lack of specific environmental data regarding Estero Bay

Southwest Florida Regional Council. 2002. Comprehensive economic development strategy.

Estero Bay Nutrient Management Partnership. 2004. Compendium of nutrient reduction projects in the Estero Bay watershed.

Pierce, R.H., Wetzel, D.L., and E.D. Estevez. 2004. Charlotte Harbor Initiative: Assessing the Ecological Health of Southwest Florida's Charlotte Harbor Estuary. Ecotoxicology 13: 275-284.

Charlotte Harbor National Estuary Program. 2005. Environmental indicators for the Charlotte Harbor National Estuary Program. Technical Report 05-1.

Southwest Florida Regional Council. 2005. Annual Report.

Barnes, T., Rumbold, D., and M. Salvato. 2006. Caloosahatchee estuary and Charlotte Harbor conceptual model. Charlotte Harbor National Estuary Program.

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Hand, J. 2004.Typical water quality values for Florida's lakes, streams and estuaries, Florida. Department of Environmental Protection, Bureau of Watershed Management. Available from Florida Department of Environmental Protection, Tallahassee, FL.

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PBS&J and W. Dexter Bender and Associates, Inc. 1999. Synthesis of Existing Information. Charlotte Harbor National Estuary Program. Technical Report 99-02.