PRNC - 182 PUERTO RICO NUCLEAR CENTER 7 PUNTA MANATÍ ENVIRONMENTAL STUDIES Prepared for the Puerto Rico Water Resources Authority, By the Staff of Puerto Rico Nuclear Center of the University of Puerto Rico April 15, 1975 ‘OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT NO. AT (40411888 FOR US ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION ---Page Break--- PUNTA MANATÍ ENVIRONMENTAL STUDIES by E.D. Wood, M.J. Youngbluth, M.E. Nutt, M.N. Yeaman, Paul Yoshioka, and M.J. Canoy ---Page Break--- PREFACE This report stems from investigations carried on by the Puerto Rico Nuclear Center. The studies were designed to provide data upon which to judge the suitability of a site for the construction of power generating facilities and to allow the determination of the impact of such construction and operation upon the environment. The report represents the combined effort of the scientists, technicians and support staff of the Site Selection Survey Project. The authors who contributed to the Punta Manatí Site Selection Survey are: E.D. Wood, Project Leader Physical, Chemical and Geological Parameters Marsh J. Youngbluth Zooplankton Studies 1973 Mary E. Nutt and Zooplankton Studies 1974 Marian N. Yeaman Paul Yoshioka Benthic Invertebrates and Fish Studies Michael J. Canoy Plant Associations Report Coordinator: E.D. Wood Technical Editor: Ferne Galantai Project Secretary: Pauline Ortega de Cabassa Data Processing Rosa Asencio ii ---Page Break--- wa 2a INTRODUCTION PHYSICAL 2.41 CHEMICAL PARAMETERS GEOLOGICAL ZOOPLANKTON STUDIES 1973 Introduction Materials and Methods Field Procedures Laboratory Procedures Results Discussion Limitations of the Data ZOOPLANKTON STUDIES 1974 Introduction Materials and Methods Field Procedures Laboratory Procedures Results Discussion INVERTEBRATES AND

FISH STUDIES Introduction Materials and Methods Field Procedures Laboratory Procedures Results Quantitative Samples Discussion Limitations of the Data 10 10 26 26 26 27 27 30 32 38 38 38 38 38 40 44 44 51 51 51 51 51 33 56 62 62 62 64 64 65 66 67 ---Page Break--- TABLE OF CONTENTS continued 4.4 PLANT ASSOCIATIONS 4.4.1 Introduction 41 41 12, Materials and Methods 4.4.3, Results and Discussion References Appendices 69 69 69 nm 7? ---Page Break--- 1.1 INTRODUCTION The Puerto Rico Nuclear Center of the University of Puerto Rico has been under contract to the Puerto Rico Water Resources Authority since 1972 to conduct site selection surveys and environmental research studies of seven coastal sites. Experience gained from these investigations will add to the knowledge about these areas and provide useful data which will aid in the assessment of the desirability and practicability of locating power generating plants on one or more of these sites. Puerto Rico Nuclear Center scientists have studied the physical, chemical, and geological parameters of the sites, and the ecological parameters of zooplankton, benthic invertebrate, and fish communities. Plant associations, except for the Cabo Rojo Platform site, have been included. The sites chosen for study were: Tortuguero Bay, Punta Manati, Punta Higuero, Cabo Rojo Platform, Punta Verraco, and Cabo Mala Pascua. The seventh site, Barrio Islote, was studied and reported under a separate contract. The first site reported was Tortuguero Bay on the north coast of Puerto Rico. The present site reported is Punta Manati, also on the north coast, west of Tortuguero Bay (see Figure 4.1-F1). ---Page Break--- 2.1 PHYSICAL AND CHEMICAL PARAMETERS AT PUNTA MANATI by ED. Wood 2.1.1 INTRODUCTION Most of the physical,

Chemical and geological measurements at the Punta Manati site were made at or near the stations shown in Figure 2.1-F1. The transects were spaced at one nautical mile with the "A" stations located as near to shore as it was safe to sample with the RMV R.F. Palumbo. The "B" stations were located in excess of 125 meters and the "C" stations on latitude 18°31.8'N in excess of 325 meters.

2.1.2 TIDES

The tidal waves that affect the north coast of Puerto Rico have their amphidromic point in the Central North Atlantic Ocean with the crest of the cotidal line moving in a counter-clockwise direction (Anikouchine and Steinberg, 1973), that flows from west to east past Punta Manati. The tides are predicted for San Juan by the National Oceanic Survey. An example of the tidal pattern over a lunar cycle has been plotted in Wood et al. (1975b) for Tortuguero Bay. The north coast tides are semi-diurnal with a maximum excursion of about 75 cm and a minimum daily excursion of about 32 cm. The mean daily tidal excursion is 40 cm. The tides for the period of current measurement at Punta Manati have been plotted in Figure 2.1-F2.

2.1.3 CURRENTS

The general current pattern on the north coast of Puerto Rico is to the west with the highest flows during ebb currents (PRWRA, 1975). The usually strong afternoon winds from the east-northeast tend to increase the velocity of the surface currents to the west. There is a strong correlation between the current patterns and the tides with modification by the local winds, the North Equatorial Current, and the direction and amplitude of sea swells impinging on the shoreline. Measurements at the Islote (PRWRA, 1975) and Tortuguero Bay (Wood et al., 1975b) sites west and east of Punta Manati, respectively, indicate that currents of nearshore surface waters reach about 30 cm/sec both east and west parallel to the coast with a net flow to the west of about 5 cm/sec. There appears to be some seasonal variation to this pattern (PRWRA, 1975).

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Fig. 2.1-F1 Punta Manati site with

depth contour lines and hydrographic sampling transects, each with three stations. ---Page Break---
“2161 ‘11 1990320 23 g 1990220 woay uene wes aos suoviStpatd uosy possord yaeuey eaung 4 Sopty 2a-1°2 “Bra oz- Ob: po noonnornennnnencnenen ~Suswsansoem ° wousn3 Le o spovs04 oz oe ov oS ve eb ve L ve a ve ecéet ue on 6 4990390 Tide Level for Pta. Manati (cm) ---Page Break--- The currents at Punta Manati were measured on two occasions, October 10, 192, using dye drops and aerial photography. The first drop was intended to coincide with peak flood current, but was delayed until almost high slack tide (0940-1230). The second drop was made at 1600 and photographed during the period of falling tide. The results are shown plotted in Figures 2.1-F3 and F4. A distinct river plume from the Manati River existed throughout the current measurements. A detached plume was seen offshore north of Punta Manati while the river discharge was spreading to the northwest, as shown in Figure 2.1-F5. Eight drops were made for each of the periods, with four nearshore and four parallel offshore. The drops furthest offshore moved slowly to the northeast, then to the southwest, and disappeared in a convergence. The offshore dye spots west of the river moved to the west at about 0.2 knots (10 cm/sec). The nearshore dye spots moved slowly to the west and were dispersed in the surf, except for the drop in the river plume. Drop three, in the plume, moved at about 0.3 knots (18 cm/sec) to the west initially, then increased to about 0.8 knots (40 cm/sec) to the west-northwest. The outer drop just north of the river plume was seen to partially disappear under the river plume. During the afternoon, the turbid water was confined to the nearshore regions. The river plume flowed to the west along the shore. The offshore dye spots moved westward and slightly shoreward at 0.6 to 0.9 knots (30 to 45 cm/sec). The drop just west of Punta Manati moved into an eddy toward the river mouth. The drop nearshore just east of Punta Manati.

disappeared in the surf after moving west at about 0-6 knots (30 cm/sec). “The drop in the inner fate plume was dispersed rather quickly to the west. The outer plume moved west near Palmas Altas at about 1 knot (50 cm/sec). The surface currents measured at Punta Manati were weak to the west nearshore and weak to the east offshore near the top of the flood. When measured near the bottom of the ebb, they were to the west at 30 to 40 cm/sec similar to those measured at Tortuguero Bay (Wood et al., 1975b) and at Tslote (PRWRA, 1975) as would be expected. 2.1.4 BATHYMETRY Contour lines for 10, 20, and 100 meters are shown in Figure 2.1-F1 and offset depth profiles of the five Punta Manati site transects are shown in Figure 2.1-FS. The depths were taken from Chart No. CCGS 903 (NOS, 1972). The shelf ---Page Break--- ---Page Break--- page “81a ---Page Break--- Pte, Manati Manati 1 Palmas Altas Vertical exaggeration Fig. 2.1-FS Offset bottom profiles along the sampling transects of Punta Manati. Vertical lines indicate relative positions of hydrographic casts. ---Page Break--- width is fairly uniform at Punta Manati at about 25 kilometers to the 100 meter contour. The shelf is a little narrower to the northwest of the Manati River mouth suggesting a submarine canyon associated with the river. A broad shallow region exists just west of Palmas Altas with the broadest portion of the shelf about 2 kilometers west. There exist a few outcrops near the mouth of the Manati River and off Palmas Altas, but no extensive reefs are found here. The vertical lines descending from the surface (transect lines) in Figure 2.1-FS indicate the relative positions and depths of the A, B, and C hydrographic stations. Most of the soundings indicated on the chart were found to be accurate. However, the nearshore regions (<10 m) are not well charted. 2.1.5 TEMPERATURE, SALINITY AND DENSITY The physical parameters of temperature and salinity were measured at the Punta Manati site on seven cruises covering four seasons in two years (Table 2.1-T1).

TABLE 2.1-T1 Schedule of hydrographic cruises to Punta Manat WATER SPRING cruises PALL 1973 at s/t12 9/7 1974 4/28 8/22 2/15 18 uA The hydrographic sampling grid is shown in Figure 2.1-F1. A maximum of five north-south transects were made on each cruise. Each transect had three stations. The "A" stations were nearshore (ca 18 m) with two sampling depths at 0 and 10 meters. The "B" stations were seaward in about 125 meters of water with four depths at 0, 25, 50, and 100 meters. The most seaward sampling was at the "C" stations in excess of 325 meter depths at about 18°31.8'N latitude with eight depths: 0, 25, 50, 100, 150, 200, 250, and 300 meters. The sampling, analytical, and data processing procedures are described in "A Manual for Hydrographic Cruises" (Wood, 1975a). Temperature Temperatures were measured using deep sea reversing thermometers accurate to better than ±0.05°C. The thermometers were used in pairs, or in triplicate when possible. 10 ---Page Break--- Although only one temperature is shown on the computer printout of the data (see Appendix 2.1A) for each depth, these values are often the average of two or three thermometers. Most temperatures below 100 meters were measured using both “protected” and “unprotected” reversing thermometers. A thermometer depth, 12, was then calculated for the sampling depths and correlated quite well with the calculated depth, CZ, obtained from the amount of hydrowire paid out, NZ, and the cosine of the wire angle, θ. An example of this correlation is shown in Wood et al. (1975b). The data were averaged by a computer program which first interpolated between the depths sampled to provide temperatures (and other hydrographic parameters) at "standard depths." The averaged standard depth temperatures and salinities are plotted by season in Figure 2.1-FE. The diagonal lines indicate density as sigma-t. Depth is not shown on the plot, but generally increases to the lower right corner of the plot, i.e., density increases with depth. Very little change is seen.

seasonally where signa-t is greater than 25.2; however, a definite change can be seen in the tower densities (surface waters). The temperature increases between winter and summer, while salinity increases between fall and spring. The averaging for the depth profiles was done first for all stations by season (Figures 2.1-F7, 9, 11, and 13), then by type of station by season (Figures 2.1-F8, 10, 12, and 14). A comparison of the averaged "C" station standard depth temperature data by season is shown in Figure 2.1-F15. A sequence of events can be seen from this comparison. Surface temperatures were lowest in the winter (25.6°C) with the deepest thermocline (100 m) caused by cooling and deep mixing by winter storms. This mixing process tends to carry heat to the depths so that the highest temperatures between 100 and 250 meters occur during the winter. (This condition is also part of a phenomenon one might call "seasonal lag.") Little seasonal change is seen below 250 meters. There was a steady temperature decrease in the 100 to 250 meter depth interval between winter and fall. No sharp thermocline existed during the spring season as relatively calm warm weather conditions allowed surface warming to occur. Surface temperatures were at a maximum in the late summer months (28.2°C) with a thermocline at about 50 meters. There was a temperature range of about 2.6° between summer and winter in the nearshore surface waters at Punta Nanati. A temperature inversion occurs in the fall as surface cooling begins. The thermocline was at about 25 meters with generally cooler temperatures between 75 and 100 meters than during other seasons. Very little difference was seen in the temperatures with distance from shore for any of the seasons. Bathythermograph traces from the "C" stations are in Appendix 2.14 and surface temperatures were mapped seasonally by serial infrared scanning (Wood, 1975).

date at Punta Manati for the years 1973 and 1976, 2 ---Page Break--- So 34 35 36 37 TC 16 1% 20 2 824 6B 100 3 xr4umo 2 2 t 200 300 [nan anaes Sena aenees eee min 0 1 2 ee PO} po-at P/I X10. PMA-1 Fig. 2.1-f7 Averaged hydrographic parameters (temperatures, TC: . salinity, '3*/oo; density, 4; dissolved oxygen, 025 and reactive phosphates PO) ‘vs. standard aeerh 4 eters for the winter season of 1993 and 1998 ae Punta Manati” 13 ---Page Break--- 50 100 I4aumo6 100 200 300 5 mult ce o.t 2 3 4 5 6 PCY po-at Pn x10, PMA-t Fig. 2.1-F8 Depth profiles of hydrographic parameters averaged by type of station for the winter season of 1973 and 1355, “ ---Page Break--- Sloe 34 35 36 37 TC 16 1B 20-22 24 26 28 & 100 ° E Pp T H m 200 300 [a eee Ses ae Qmno 1 1 2 4 5 6 PO} po-at P/Ix10 Pye Fig. 2.1-F9 Averaged hydrographic parameter depth profiles for the spring season of 1973 and 1974 at Punta Manati. 6 ---Page Break--- 507 (Pp o\\s o A 100 | db oO c E P T H 100 m P L of\e |s 200 300 Oymino 1 2 3 4 5 6 POA pg-at Pr x10 PMA-2 Fig. 2.1-F10 Depth profiles of hydrographic parameters averaged by type of station for the spring season of 19 and 1974 ON ---Page Break--- Tc ° 100 . E P T H m 200 300 oy Qmno 1 4 2 6 PQ§ pg-at.P/Ix10 PMA-3. Fig. 2.1-F11 Averaged hydrographic parameter depth profiles for the summer season of 1973 and 1974" ” ---Page Break--- 50 100 I4umo) 100 200 300 mill Oo 1 2 6 p9-atPIxi0 PMA-3 Fig. 2.1-F12 Depth profiles of hydrographic parameters averaged by type of station for the summer season of 1975 and 1974, 18 ---Page Break--- TC 16 18 20, 22 24 26 2B 100 D E P T H m 200 300 nen aA Gene min oO 1 2 3 4 5 6 POS pa-at P/1X10 PMA-4 Fig. 2.1-F13 Averaged hydrographic parameter depth profiles for the fall season of 1974. 19 ---Page Break--- S%o0 34 35 36 37 Tee 16 18 20 22 24 26 28 ° TB 504 |p a 100 <I\ DO re E P T H 100 m P ° io Js 200 L 300 [nc ee Op mill 0 1 2 3 4 5 6 PG po-at P/1xi0. PMA-4 Fig. 2.1-F14 Depth profiles of hydrographic parameters averaged by type of station for the fall season of 1974, 20 ---Page Break---

TEMPERATURE °C 16 18 20 22 24 26 28 30 35 30 rawmo 200 Fig. 2.1-F1S Averaged seasonal depth profiles of "C" station temperatures at Punta Manati for 1973 and 1974. a ---Page Break--- Salinity Salinity, S/oo, is the total salt content of water expressed in parts per thousand. It is used along with temperature to typify ocean water masses. Low salinity usually occurs at the surface and indicates dilution by precipitation, runoff, or freshwater intrusions. High salinities are found in subtropical regions and are the result of high rates of evaporation. The salinities at Punta Manati were determined using an induction salinometer with the readings good to better than + 0.05/oo.

The average seasonal salinity data are shown plotted against depth with the other hydrographic parameters in Figures 2.1-F7 through F14. It is immediately obvious that there is a pattern throughout the year for salinity to increase with depth (as temperature decreases) to a depth of about 150 meters where salinity begins to decrease slightly, becoming fairly uniform with depth at about 36°/oo. This layer of high salinity water with a maximum of about 37°/oo was formed by evaporation in the subtropical North Atlantic Ocean. A comparison of the averaged "C" station salinity data is shown in Figure 2.1-F16. The winter salinity profile shows a generally low salinity in the upper 150 meters and the deepest maximum at about 190 meters. The shallowest maximum occurs during the fall season at about 125 meters. The fall maximum is lower than during the remainder of the year and the lowest surface salinities (34°/oo) occur during this season. Surface salinities generally increase from fall to spring (34 to 36°/oo) then decrease through the summer into fall during the intensification of the tropical rainy season. A general increase in salinity was observed in the 25 to 125 meters layer between winter and fall with almost the reverse true between 150 and 250 meters. The salinity of the Manati River is near zero; however, the lowest salinity at the

closest "A" stations was about 32°/oo indicating how fast the river water is mixed with the sea water. The depression of the nearshore surface salinity rarely extends beyond the "B" stations. Isohaline lines have been drawn from surface salinities for the fall of 1974 in Figure 2.1-F17. The sampling was done during the night and early morning when wind conditions were light from the east. The tide during the time of sampling went from a level of 30 cm to a low of 0 then a high rising tide of about 60 cm. The combination of weak easterly winds and weak ebb current followed by a strong flood current during the rainy season explains the extent of the Manati River plume. ---Page Break--- SALINITY "oo 35 36 37 ° NYE ’ “ 100 D € Pp T 4 H m 200 4 PMA winter Spring 2 Summer 3 Fall 4 300 3 Fig. 2.1-F16 Averaged seasonal depth profiles of "C" station salinity at Punta Manati for 1973 and 1974. 23 ---Page Break--- ---Page Break--- DENSITY of 20 22 24 26 100 3 r40mo 300 t) profiles of "cv season for Punta Manati, Fig. 2.1-F18 Averaged water density (si Station data plotted by 1973 and 1974, 25 ---Page Break--- Density The stability of the water column is a function of the density gradient. Density, ρ, is a function of temperature and salinity, and always increases with depth in a stable water column. Density is usually converted for convenience to an expression sigma-t, $\sigma = (\rho - 1000) \times 10^3$. Small changes in sigma-t with depth indicate a well-mixed or unstable zone, whereas a high gradient is indicative of a very stable region of the water column. A comparison of the averaged seasonal sigma-t profiles is shown in Figure 2.1-F18. Sigma-t varies from 22 to 24 in the surface waters and is highest in the winter months. The pycnocline occurs at about 100 meters in winter because of deep storm mixing and generally cooler surface temperatures. The most stable water column occurs in the fall when surface water density decreases because of dilution. A general decrease in sigma-t occurred from winter to fall at the surface, while

The opposite was seen at about 100 meters. Very little seasonal change in sigma-t was seen below about 200 meters. The tendency for slightly higher sigma-t values in the station over the "B" and "C" stations noticed at the Tortuguero Bay site (Wood et al., 1975b) was not seen at Punta Manati, probably because of contributions from the Manati River. Sigma-t profiles are shown in Figures 2.1-F7 through F14.

2.2 CHEMISTRY

2.2.1 DISSOLVED OXYGEN

The amounts of dissolved oxygen, D.O., in the water off Punta Manati were determined by the

Winkler titration method, with the analyses usually performed on shipboard within a few hours of sample collection. Some of the values were checked with a YSI polarographic probe, with results similar to those reported for Punta Higuero (Wood, 1974). The titration values were more consistent and generally higher than the probe readings. The titration values are generally good to better than *Tt; however, some analytical problems were experienced on the 1973 winter cruise. Dissolved oxygen data are included with the phytographic data in the Appendix 2.14 in ml/t, mg/t, and ‘sate. Oxygen saturation is a function of both temperature and salinity. Since neither shift drastically in the tropics, little change in near surface D.O. is expected, nor was it seen.

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Averaged D.O. values in milliliters per liter are plotted with other hydrographic parameters in Figures 2.1-F7 through F14 by season and type of station. The highest values, except for the winter season, were found at about 100 meters. Surface values were near saturation with some super-saturation at depths of 25 to 75 meters because of photosynthesis. A comparison of seasonal averaged values is shown in Figure 2.2-F1. The oxygen minimum occurred at about 225 meters for all seasons except fall, where a very pronounced minimum was seen at about 150 meters. Slightly higher D.O. in the surface waters during fall and winter seasons is consistent with higher D.O. saturation with lower temperature and salinity. Generally,

very little seasonal change was noticed in D.0. 2.2.2 NUTRIENTS Nutrients are important from two aspects. First, nutrients are generally low in the tropical Atlantic Ocean surface waters and limit primary productivity. Second, the discharge of wastes from agricultural, municipal or industrial sources may contain such high nutrient levels that they cause eutrophication and local ecological degradation. Reactive phosphate can be determined quickly and accurately with the Murphy and Riley molybdate blue complex method (Strickland and Parsons, 1968) and is a good indicator of pollution. Only a limited number of nitrate analyses were performed on the waters off Punta Manati. The tropical and subtropical North Atlantic is generally deficient in nutrients, especially nitrate. Reactive silica is usually not regarded as a pollution problem. Reactive Phosphate The concentration of reactive phosphate is generally low in the surface waters (0.05 µg-at. P/l), slightly lower in the summer and slightly higher in the winter as seen in Figure 2.2-F2. The levels of phosphate were uniform to about 200 meters where they began to increase, being 0.3 to 0.5 µg-at. P/t at 300 meters. The increase in phosphate generally coincides with the decreased salinity below the salinity maximum. This is because the high salinity water was formed in the subtropical North Atlantic which is deficient in nutrients. Slightly higher phosphate values were seen in the nearshore surface waters, especially near the mouth of the Manati River, probably from agricultural runoff, a ---Page Break --- DISSOLVED OXYGEN mi/l 3 4 5 6 100 3 r40mo 200 winter 4 Spring 2 ‘Summer 3 4 300 Fall Fig. 2. “FI Averaged dissolved oxygen depth profiles by season, 1973 and 1974, 28 ---Page Break --- REACTIVE PHOSPHATE _ g-at. P/l 00 | 01 02 03 04 05 06 100 wi Favmo 300 Fig. 2.2-F2 Averaged reactive phosphate depth profiles by season, 1973 and 1974, ---Page Break --- Nitrate Nitrate was determined by the cadmium-copper reduction method (Wood et al., 1967). Samples were analysed

for nitrate at Punta Manati only for the fall 1974 season. (Nitrates have been done routinely at the Islote site about 3 kilometers to the west and the data is available in Kendall et al., 1975). Nitrate profiles for the PMA-3A, B, and C stations are shown in Figure 2.2-F3. They are similar in shape to the phosphate profiles for the same season except that the higher surface values for the "A" and "B" stations are much more pronounced. There is obviously a large source of nitrate in the Manati

River region, possibly from agricultural sources or from industry. 30 ---Page Break--- Nitrate g-at.N/I 2.4 6 8 10 12 14 16 18 ° ——— B 100 PMA-3 © Oct. 31, 1974 E P T a H m 200 300 Fig. 2.2-F3 Plot of nitrate vs. standard depth for the fall season of 1974, 3 ---Page Break--- 3.1 GEOPHYSICAL PARAMETERS AT PUNTA MANATI by E.D. Wood The beach outcrops are Pleistocene cemented dunes as are the high grounds on either side of the Manati River (Briggs 1965). Much of the shoreline is composed of well-consolidated sand (Figure 3.1-F1). Some of the sand deposits landward from the beach contain fine-grained quartz sand and clay, especially near the Manati River. The cross-hatched area is alluvium deposited by periodic river flooding (Hickenlooper 1967). Sediments in the shaded areas along the shore were deposited by storm and wave swash and wind (Fields and Jordan 1972). Sediment deposits largely from the Manati River exist seaward and to the west of the river. There is a region just east of the river mouth that is usually hard bottom; this area just north of Punta Manati is covered by Station PUA-4h (Figure 2.12F1). It had been reported that sand moves on and off of some of the hard bottom; however, attempts to retrieve sediments from PMA-4A have been fruitless. The ocean bottom areas shaded in Figure 3.1-F1 were drawn from aerial photographs taken in August 1973. Sand was visible near Palmas Boquilla and north and west of the Manati River with a tongue of sand running west just offshore north of Palmas Altas. The sand deposits

West of Palmas Altas, sediments were confined to several patches. Sediments collected at PMACTA, 2A, Sk, and SA were sieved, and the results are shown in Figures 3, 12F2, and F3. (All of the samples are unimodal, with the highest percent of sediment collected on the 38 (125 µm) screen. The statistics for the sediments are in Table 34-1.

TABLE 8.1-T1 Statistics for the Funta Manati sediments

STATION	PMA-14	PHA-24	PMA-3A	PUARSA
Median (µm)	28	28	29	27
Mean (µm)	29	28	29	27
Standard deviation (µm)	6.0	0.6	0.68	0.5

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Value and weight percent plots of sediments from Stations PMA-1A and 2A.

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Histograms and cumulative weight percent plots of sediments from Stations PMA-3A and SA.

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The shape of the histogram of PMA-3A differs somewhat from those sediments west of the Manati River, with over seventy percent of the sediment collected on the 3/8" screen and only 0.48 less than 1 µm. The plume of the Manati River has been observed on numerous occasions. The dominant pattern is to the west along the shore, as shown in Figure 3.1-F4. With periods of light winds and a flood current, the pattern changes to the east with more spreading. On rare occasions (high river discharge and a near calm sea), the plume may be seen to spread in an arc several kilometers from the river mouth as a thin layer of muddy, low salinity water overlying the seawater. The river produces very little discharge during the dry season. The usually turbulent north coast sea conditions rapidly mix the river water with the seawater, so that the effects (e.g., low salinity) are rarely seen beyond the "A" stations even during the rainy season.

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---Page Break--- 4a ZOOPLANKTON STUDIES 1973 by Marsh J. Youngbluth 4.1.1 INTRODUCTION The following report provides estimates of the abundance and density of zooplankton in the surface waters along a portion of the north coast of Puerto Rico. These data form one part of an environmental survey conducted by the Puerto Rico Nuclear Center. All collections were gathered in an area adjacent to the region proposed for the siting of a future power plant. Samples were gathered on 3 days during 1975: 29 January, 11 May, and 7 August. 4.1.2. MATERIALS AND METHODS Field Procedures Zooplankton were collected with a 1/2 meter diameter cylinder-cone shaped nylon net. This net was designed to reduce clogging error (Smith et al., 1968). Mesh size was 233 microns. The net was towed from a 12-foot skiff in a circular path through the upper 2 meters. The speed of the vessel ranged from 2 to 8 knots (determined with a Sims yacht speedometer). The duration of a tow was 10 minutes. After each tow, before the cod end was removed, the net was washed with seawater with the aid of a battery driven pump (12 volt, Jabsco water-puppy). The catch was preserved in 4% seawater formalin buffered to pH 7.6. All samples were gathered during the daylight hours. The volume of water filtered through the net was estimated with a flowmeter (TSK or General Oceanics Model 2030) suspended off-center in the mouth of the net. The volumes usually ranged from 100 to 150 m³. The meters were calibrated every 2 months. Calibration factors fell within 8% of the mean. At each site, three tows were made in the area adjacent to the region where a power station may be located. Single tows were taken at the other stations. The regions sampled were chosen in such a way as to collect within and around the area where thermal alteration is likely to occur (Figure 4:1-F1). Laboratory Procedures Within 24 hours after samples were collected, the pH was checked and adjusted, if necessary, to 7.6. If a sample contained a noticeable conglomerate of phytoplankton or detritus,

the zooplankton were separated from such material by gentle 38 ---Page Break--- ssuoraeas woayuetdooz f2eueK wrung E761 JO UOTI"D0T ---Page Break--- filtration through 202 micron mesh netting. Before estimates of biomass or numbers were made, all organisms larger than 1 cm, usually hydrozoan medusae, were removed. Biomass was calculated as wet volume (Ahlstrom and Thraikill, 1962). This estimate is subject to considerable error and should be viewed only as a rough measure of standing stock. The measurements were reproducible but are undoubtedly biased toward higher than actual values by variable proportions of interstitial water and detritus. The total number of organisms was estimated by volumetric subsampling with replacement (Brinton, 1962). Three aliquots from each sample were counted. The abundance of major taxonomic groups of holoplankton and meroplankton were determined from dilutions of 300 to 500 organisms. Copepods, usually the most numerous of the zooplankters, were identified to species. All biomass and enumeration data were standardized to a per cubic meter basis or multiple thereof. Data were initially reduced with hand calculators (Hewlett Packard Model 45) and more recently with a computer (PDP-10). See Appendix 4.1A for a listing of the program. 4.1.3 RESULTS A total of 21 samples was collected from 5 stations (Figure 4.1°F1). The densities of several taxonomic groups of zooplankton at each station have been determined (Tables 4.1-1°5 through 17). These data are arranged to facilitate comparisons between sets of consecutive tows, nearshore tows, and offshore tows. The densities of total zooplankton usually varied more between catches from different areas than between consecutive samples from one area. The degree of variation between samples is expressed as a ratio, formed by dividing the largest total number of zooplankton by the smallest within each set (Table teIeTi). The ratios are similar to those observed in other coastal regions around Puerto Rico. Another way of judging

Differences between samples was determined by calculating the variance between consecutive samples and estimating the number of tows needed to detect various levels of difference (Table 4.1). ---Page Break--- TABLE 4.1-T1, Summary of ratios between the highest and lowest density values of total zooplankton during each period DATE 29 January 1 May 7 August Consecutive Tows 1.2 18 Nearshore Tows Offshore Tows 2.9 2.3 1.3 ALL Tows 3.8 2.8 3.0 TABLE 4.1-T2. Total zooplankton (log transformed) from 9 sets of replicate tows. The number of replicate tows (n) needed to detect a 5 to 50% difference in density is indicated. DATE 28 January 1 May 7 August STATION 1 1 2 2.69197 2.56110 2.33648 2.78675 2.70759 2.18679 2.73798 2.71517 2.19988 1 7 208 1 508 1 Were (+) t Student's t for the 95% confidence level G2 (df=2), 62 is the sample variance based on replicate tows, and c is the half-width of the confidence interval desired. These data indicate that a large number of replicate tows would be necessary to detect density differences at the 5% level. However, on average, differences of 20% can be noted with only 3 tows. Differences of 50% may be revealed with a single tow. Density estimates larger than 50% were found within and between nearshore and offshore catches. The range of density values during a sampling period was usually two to four-fold. ---Page Break--- Seasonal changes in the abundance of total zooplankton at any station or among all samples fell within the same range (Table 4.1-T7). The highest concentrations occurred in January. The larger densities, however, probably represent the range of variation among tropical zooplankton communities in the coastal waters around Puerto Rico rather than recurrent seasonal pulses since the 95% confidence intervals from each station overlap (Table 4.1-T3). TABLE 4.1-T3, Average density of all zooplankton collected Total Zooplankton/m³ 29 January 11 May 7 August Range 742-166 464-159 476 Median 550 373 299 Mean 80 340 202 958 Case #12 365

‘These fluctuations in density refer primarily to holoplanktonic organisms since they composed, in most cases, 60 to 90% of the total zooplankton. Meroplankton formed 3% to 25% and were equally numerous during each sampling period. Copepods dominated the holoplankton and the larvae of gastropods and carideans formed the bulk of the meroplankton. Fish eggs were abundant in this area, constituting 2% to 25% of the total zooplankton (Table 4.1-T4). The largest density, 87/m³, was observed at Station 4 on 29 January 1975. Fish eggs were somewhat more numerous in January and August when they averaged 39 and 33/m³, respectively. Most of the eggs were round and 0.5 to 2 mm in diameter; oblong eggs were common. It is not known which groups of fish are represented by most of the eggs. TABLE 4.1-TH. Summary of densities of fish eggs from all stations sampled at the Punta Manati Site STATION Range 17-98 16-35 3-47.87 21-38 387 Median 2% 8a 2 ot 28 Mean 7 et 3 ot 23 a2 ---Page Break--- Copepods formed 50 to 85% of the zooplankton community. A total of 39 species were identified. Time did not allow a detailed study of species abundance at all stations; consequently, one sample at Station 1 from each period was selected for study. The entire sample was scanned to form a species list and subsampled for quantitative analysis. Using these data, the species most numerous, those commonly observed, and others occasionally found, are listed in Table 4.1-TS. TABLE 4.2-T5. Copepod populations observed at the Punta Manati Site Species usually most numerous (5 individuals/m³) Clausocatanus furcatus Faracalanus spp. (F. aculeatus, F. gracilis) Oithona spp. (O. similis, O. spp.) Keartea spinaca Tenora turbinate Species commonly present (observed on 2 or more sampling periods) Centropages spp. (C. giesbrechti, C. pacificus, C. typicus, C. subulatus) Corycaeidae (E. embawehes, C. pacificus, C. speciosus, C. subulatus) Oncaea spp. (O. Bedi, O. jenusta, O. diabolica, O. vulgaris) Salocalanus pavo Rocinocera clausi Species

occasionally present Eucalanus spp. (E. mucronatus, 2. app.) Tasleutfa flavicomis ieee copii Tabidecers spp. icfa pachydactyla ‘Herocatants longicornis Pontella piuats Eis gracinis Macrosetelia 3 ---Page Break--- 4.1.4 DISCUSSION The variety and abundance of zooplankton observed at the Punta Manati site were similar at each station and throughout the year. Holoplanktonic forms dominated the zooplankton community. Meroplanktonic organisms, particularly the larvae of gastropods and decapods, and fish eggs were equally numerous. No obvious patterns of distribution were apparent among the zooplankton sampled along the coast or offshore. Limitations of the Data The sampling program was designed to provide quantitative estimates of 1) the standing stock of zooplankton, 2) the variety of major taxonomic groups, and 3) the diversity and abundance of the more numerous copepod species. The manner of field sampling determined the variety and biomass of organisms encountered. The data in this report are based on collections made in the surface waters during the daylight hours. The sampling gear and methods were kept uniform, i.e., net type, net mesh, towing speed, and depth range sampled. A small number of replicate tows were gathered at each site to obtain some measure of the variability between samples. To obtain a better understanding of the zooplankton community, more sampling with replication should be done at frequent intervals, at a greater number of stations, at different depths, during the day and night, and during different seasons for several years. Information gathered in these ways will be necessary to interpret fluctuations in standing stock and diversity in relation to environmental changes and biotic interactions. ---Page Break--- “parnsvou 304 y est eer we eeu eer est te ex800 ae eee ete een ers ors ge eusort we ate wet 60L oss a ecro6z s * e 2 ¢ oF 7 7 sae SuOTTESS TOES TS sxoy ex0ussz0 nox exoysavon nog axeoptdag exouszeext TeuPERAMT UOSRCPTEOOE Go TequME TCL Tier Sieve - - : - - - yec80L

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Animals larger than 1 cc were removed. Approximately 24 hours after collection, the biomass was measured by volume displacement (Ahlstrom and Thrailkill, 1962). Zooplankton abundances were estimated by subsampling. The sample was poured back and forth between two large beakers until thoroughly mixed, at which time a subsample was poured out. Repeated subsampling of a single sample showed all groups of organisms to be randomly distributed by this method. In all cases, subsamples contained more than 450 animals. Each animal was identified to major group and counted. The dominant copepods were identified to species. When replicate tows were taken, confidence intervals were calculated from the equation, r + where r is the estimated mean, t is Student's t-value, s^2 is the estimated variance, and n is the number of samples.

4.2.3 RESULTS

Zooplankton found in the Punta Manati samples are listed in Table 4.2-T1. Copepods are invariably the most abundant organisms, followed by fish eggs, chaetognaths, and larvaceans. Other animals such as ostracods, pteropods, and gastropod veligers are occasionally numerous, but are not always present in the plankton. Copepods were represented by 48 species, but 80 to 90 percent of these consisted of four species (Temora turbinata, Clausocalanus furcatus, Paracalanus sp., and Oithona unifera). Seven other species were consistently present: Femora stylifera, Nannocalanus minor, Calanopia americana, Acartia pinata, Farranula gracilis, Corycaeus spp. and Siewa spp. The remaining copepod species appeared sporadically and in numbers less than 5 per cubic meter. Fish eggs ranged in abundance from 40 to 117 per cubic meter. Most were clear, round, pelagic eggs. No attempts were made at identification. Fish larvae ranged from 0 to 8 per cubic meter. No identifications were made. No spiny lobster larvae appeared in the samples. Table 4.2-T2 shows individual values, means, variances, and confidence.

intervals for one set of replicate tows made on 31 October 1974 at Station 2. Most of the variances are significantly higher than their means (x° distribution for the variance-to-mean ratio) which indicates a non-random or "patchy" distribution. The confidence intervals are wide but realistic for marine zooplankton distributions (Wiebe and Holland, 1968) and must be considered whenever @ mean ---Page Break--- TABLE 4.2-T1. HOLOPLANKTON ‘COPEPODS Calanoids: Nannocalanus minor Undinula vulgaris Fucalnus attenuatus Rerocatanus Tongioratus Eucalanus anderson = Paracalanus aculeatus Clausocalanus furcatus ‘Euchaeta marina Beolacthnae danse Temoera septentrionalis Tenura pages furcatis Ectyocorycae eutla Plavicornis Candacia p. pachycephala penal ee Taptiseara ap Halopeltis Tongioratus. Harpacticoids: Microsetella efferata Macrosetella gracilis Ueulostella gracilis. Enteropneustes = cyclopoid: Oithona plumifera ‘Oithona setigera ‘Oithona oculata Saphirella topica Sphaeroma quadrara Siphonostoma (ceomeamns) easee = epee ‘igetaad Face Corycaeus (Agetus) limbatus 54 Zooplankton from Punta Manat a2 a us Corycaeus) Latus Corycaeus (jeaeus) agilis Oneaee ‘mediterranea Saphirella Farranula ---Page Break--- Table 4.2-T1 (continued) ‘CHAETOGNATHS ‘TUNICATES Sagitta hispida Eptitrea eafacs Talia denocnati Sees Feta serratoedentata Pouroures fronts Sut Prorosagitta draco Tonopteris sp. ARTHROPODEANS ETOPROCT LARVAE Okeipura sp. Membranipora membranacea Petalimanis peazuciana GASTROPOD VELIGERS PREHENSILE LARVAE ‘iscins retroverea CHRYSIPED LARVAE seeseie acieats Squideta subule RINODERM LARVAE Ostracods ophteptuteus Larvae Echinopluteus larv. Euconchoscia chierchiae FISH LARVAE ‘MEROPLANATO FISH B63 [STOMATOPOD LARVAE, ANdHTPODS DECAPOD LARVAE Caridea ‘Alpheus sp. Feknthtyra op. Penaetde Seyliaridea Palicurus sp. calatheides Porcellana sp. brachyura sencrsrins Lucifer sp. cuapoceans Bvadne ep. Fenftfa sp. MEDUSAE SIPHONOPHORES CTEWOPHORES 55 ---Page Break--- Se TABLE 4.2-T2, Variability among zooplankton

replicate tove at Punta Manati, Station 2, 31 October 1974 (Abundances in numbers per cubic meter) as Total Chaetognaths Larvae Malacostraceans Fish Zooplankton Copepods eggs Tow A 1132 82 3 7 Tow 8 1878 12 48 6 83 Tow C 1702 1968 25 68 18 108 Mean 1568 42 8 82 Variance 21008 15276219, 519 BE C.T. 1208 to EK to «S$ to 78 $3 to 107 0 to 29 26 to 1920 1878 139 a Figures 4.2-F2 and 4.2-F3 show the 95% confidence intervals for the more abundant zooplankton groups at Station 2: copepods, malacostracans, chaetognaths, larvaceans, fish larvae, and fish eggs, as well as total numbers and biomass. Appendix 4.24 shows abundances of zooplankton groups for all stations and sampling data. Appendix 4.28 shows abundances of the common copepod species for all stations and sampling data. With the exception of fish eggs, the zooplankton is somewhat sparser at the offshore station. 4.2.4 DISCUSSION In both species composition and abundance, the zooplankton at Punta Manati is similar to that at Islote and Tortuguero Bay (Figure 4.2-F4). No important differences between sites can be seen; when a zooplankton group dominates the plankton at Punta Manati, it can usually be found in samples from the other two sites. Youngbluth's data from the previous year (see Section for a report) show substantially fewer zooplankton than were found in 1974. This discrepancy is probably due to differences in sampling methods; Youngbluth used surface tows, Nutt used oblique tows. (See Table 4.2-T3 for a comparison of surface and oblique tows at Islote.) In general, the same zooplankton groups and species were seen both in 1973 and in 1974. 56 ---Page Break--- Copepods 2800 2000 y 7 120 q d Y A ry so» J 4 E Ta May 18 Aug ST Oct Ta Way 18 Ag 3T Oct Larvaceans Chaetognaths 100 -| Y 100 -| Y q 20 -| Y 80 Y y wo, 4 «4 H 4 wo 10 4 Y 7 4 4 “go “ly a ¢ 1a May 15 Aug 31 Oct 14 May 15 Aug 31 Oct Fig. 4.2-F2 Zooplankton abundances at Station 2:

95% confidence intervals for total zooplankton, copepods,

larvaceans and chaetognaths. 57 ---Page Break--- Biomass 20 60 -| 20 - Matacostracans 14 May 15 Aug 31 Oct Fish Larvae a 120 -| 40 -| T4May 15 Aug 31 Oct Fish Eggs ESSSSSSSS a SSSSSSSSSSSSI 15 Aug 31 Oct 14 May 15 Aug 31 Oct Fig. 4.2-F3. Zooplankton abundances at Station 2: 95% confidence intervals for biomass, malacostracans, fish larvae, and fish eggs. ---Page Break--- ISLOTE MANATI TORTUGUERO proms 8 | i common 0 | ail ! | J | Chaetognaths Larvaceans Malacostracans Fish age I rome | | 15 May 20 Aus 5 Nov 1 May 15 Aug ato Le 4 May 15 Aug 31 Oct Fig. 4.2054 4 comparison of zooplankton abundances at Islote, Punta Manati, and Tortuguero Bay" ---Page Break--- ue 6e +8 18 car L020 ns or 0 oer crm | on ne on est +10 486 eo eee eet “a 8 se sure | sete | eoursaey z se se aw 99 6e ose ceo roy € ze 5 ze 1 st ne 9 ste0 z zs a of us ee vom 280 080 z ze ¥ 2 su on 908 808 sno ‘mos anbTT90 aworol wos 06 03 0 = 60 sae 2 o| exe oro | «3-0 a6 toe o 80m * ezso_ | szeoz_| sourssey t se or on . est ere wesK t ee 9 8 ° * att 652 oneo + oe % az ° z sor a s260 t an z es ° ° nse *0" st60 seasey usta | sy ysra | oearet avo | spodosasey [spooesasy | _ suseu | epodedoy | trou 2s s00eT eH ~Soi9e4 nox sovzins (20x0m o¢qno aed soquny) sugt Trady LT Z uoraess ‘mors Ie sMca uoaxuetdooe soesuns pue snbyTqo Jo SoEpaEsaCO Y “eL-z*y SIEVE ---Page Break--- With quarterly sampling it is difficult to assess seasonality in the plankton at Punta Manati, but the data seem to indicate changes which repeat themselves. For example, the copepod Temora turbinata dominates the plankton on 14 May 1974, is sparse in August, and appears again on 31 October in numbers greater than before. This pattern is seen also at Islote and Tortuguero Bay. At this time it is not known whether this repetition is seasonal or random, and there has been no attempt to correlate these fluctuations with physical, chemical, or other biological parameters. As both fish eggs and fish larvae are abundant along the north coast of Puerto Rico, we recommend that any further work at

Punta Manati involves a full-scale study of ichthyoplankton. Many of the reef fishes produce clear round pelagic eggs, but so do the commercially important snapper, grouper, and other food and game fishes. It is not known whether the eggs found in the Manati region are produced locally or by fish living in other areas of the north coast. The existing data provide little information on the vertical distribution of the zooplankton. Since oblique tows capture more animals than surface tows, evidence exists that the majority of the zooplankton are not at the surface during the daytime hours. We recommend that oblique tows, or a combination of surface and bottom tows, be used in the future. Studies at Islote revealed a significant diurnal migration of Brachyuran and Caridean larvae (Youngbluth, 1974). Future work at Punta Manati should include a study of vertical distribution and migration. 6 ---Page Break--- 43 BENTHIC INVERTEBRATES AND FISH STUDIES by Paul Yoshioka 4.3.1 INTRODUCTION This report covers benthic studies made at Punta Manati from May 1973 to August 1974. The Punta Manati site was visited, but not on a predetermined schedule during this interval. Study stations ranged in depth from 5 to 33 meters. The scope of studies ranged from preliminary descriptive surveys to the establishment of a permanent station. Organisms examined in this study ranged in size from the microscopic infaunal populations to the macroalgae and fish. During the latter part of this study, a major portion of the investigative effort was spent on the macroalgae. Various aspects of the ecology of the macroalgae were examined as to distributional and temporal patterns of presence and absence, abundance, and species diversity. 4.3.2 MATERIALS AND METHODS Field Procedures Field stations at Punta Manati are given in Figure 4.3-F1 and Appendix 4.3. Field collections are divided into three categories: fish collections, transect dives, and station dives. Fish collections: All fish collections were done in the nearshore (≤ 5m) area. Fish were poisoned with rotenone (PRONOX-FISH) and collected with dip nets. Fish were collected on four occasions. Sampling sites included both sand beach and rock areas. Transect dives. Transects were traversed on a predetermined compass direction by two divers, either swimming or propelled by a diver propulsion vehicle (DPV). Notes were taken on depth, bottom type, topography, and dominant or unusual organisms. Most of the transects were run in a direction perpendicular to the shoreline, thereby traversing a depth gradient. Several transects were run parallel to the shoreline to observe changes in benthic communities relative to factors other than depth. ---Page Break--- Stations dives. Dives were made at several stations to collect quantitative samples. Algae and bottom substrate were collected in 1/4 m^2 samples. Replicates were taken whenever possible. Algae were sampled by hand, and bottom substrate with the aid of a hammer and chisel. Both were placed immediately in plastic bags held adjacent to the collecting site. Algae and/or bottom substrate were collected at stations. Photographs were taken when conditions permitted to aid in the general description of the area. The presence and absence and relative abundance of the larger invertebrates and fish were noted during the latter stages of the investigation. Laboratory Procedures Algal and substrate samples were brought to the laboratory, sorted in phylogenetic groups, and preserved in 70% ethyl alcohol or 10% formalin for later identification. References used in identifications are listed in the bibliography. The samples were often frozen prior to sorting. When sufficiently abundant, both the dry and wet weight of the algal species were recorded. 4.3.3 RESULTS Description of the study site. A fine-grained blackish sand, probably of terrigenous origin, was found to be the predominant substrate in the immediate vicinity of the mouth of the Manati River. The same

Substrate was observed at depths over 25 meters, about 1/2 mile offshore of the river. No demersal fishes were observed in the sandy areas. The only noticeable benthic organisms were occasional patches of the plant Halophila, observed at 25 meters. Other organisms observed on the sand habitat at the Punta Manati site were the sand dollar Mellita sexies perforata, the sea pansy Renilla sp., the starfish Astropecten sp., and the crab Callinectes sp. Beachrock is the predominant substrate offshore from the rocky headlands to the east and at depths less than 15 meters to the west of the Manati River. The substrate is usually flat, although at places a depth gradient is noticeable. Occasional rocky outcrops or depressions up to 1.5 meters high or deep, and several meters across are encountered. Hard coral fauna exists (<1% surface cover). Occasional gorgonian colonies are found, principally Pseudopterogorgia foliosa.

Most of the fish life observed (~90% of the individuals, 2708 of the species) occurred in the vicinity of rocky outcrops or depressions. Also, the urchin Diadema and the delicately colored hydroid Stylaster were found only in such areas. Shelter appears to be a major factor determining the presence of these animals. Stylaster grows under ledges and Diadema was found only in crevices. Fish and large invertebrate species observed and identified at the Punta Manati site are listed in Appendix 4.3B. Fish species collected at the nearshore poison stations are listed in Appendix 4.3C. Quantitative Sample: Infaunal and epifaunal species identified in the 1/4 m^2 substrate samples are listed in Appendix 4.3D. Excluding algae and colonial forms, a total of 48 species were found in the three substrate samples. The numbers of individuals were quite equally distributed among the species. Most species were represented by only one or two individuals, which suggests that they are "rare" relative to the quadrat size. For instance, the 14 species found in replicate A (Station 3) were

represented by only 22 individuals and the 11 species in replicate B by 17 individuals. The "rareness" of the species probably accounts for the lack of similarity between the samples; only one species was found in common between replicate B (Station 3 and Station 1), and 4 species between Station 1 and replicate A (Station 3). The lack of similarity between the samples cannot be attributed to large-scale habitat differences. Replicates A and B (Station 3) had only three species in common, although the samples were taken a few meters apart. It would appear that due to infaunal distribution patterns, the 1/4 m^2 quadrat is inadequate to representatively sample the infaunal community. A total of 28 algal species were recorded from three quadrat samples at Station 2 in June 1974 (see Appendix). Only 11 species occurred in all three samples, but these species accounted for 88% of the algal biomass. These species also showed significant concordance in their relative abundance in biomass (Kendall Concordance Test, $p<0.01$), indicating that a 1/4 m^2 sample gives an adequate portrayal of the algal community structure. The dominant algal species in decreasing order of abundance were Dictyopteris plagiogramma, Bryothamnion triquetrum, coralline algae, Pococktelia eariegata, and Anansia aiTtt fda. These species accounted for over 80% of the total algal biomass. Algal biomass ranged from 182 to 219 g (wet weight). Samples taken at Station 2 in August showed several differences. Algal species diversity was lower; each replicate contained 13 species. In June, the number of species per replicate ranged from 16 to 20. The difference is significant at the 0.1 level (Fisher Randomization Test). No correlation was found between the relative abundances of species in the two replicates; consequently, algal community structures derived from these replicates may be artifacts of sampling variability. However, the more abundant algal species appear to be coralline red algae, Dictyopteris plagiogramma, Bryothamnion.

triguetrum, and Halimeda Giscoigen The two replicate samples taken at Station 4 in August displayed an even greater amount of variability. Algal biomass ranged from 3.6 to 119 g per 1/4-m and the number of algal species from 6 to 15 per quadrat. No correlation was found between the relative abundances of species in the two replicates. However, the most abundant algae was Sargassum polyceratium. A significant correlation between the relative abundances of algal species was found for the two replicates taken at Station 3 in June (Kendall-Tau, $p < 0.05$). Algal biomass ranged from 304 to 588 per quadrat, which was greater than the algal biomass at Station 4 in June. The dominant algal species in decreasing order of abundance were the coralline red algae, Dictyopteris plagiogramma, Anansia multifida, Bryothamnion triquetrum, and Botryocladia occidentalis. These species account for over 50% of the algal biomass. In summary, no trend was found for algal biomass through time or depth. Algal species diversity increased with depth (Stations 2 and 3 in June, and Stations 2 and 4 in August) and decreased from June to August (Station 2). However, these trends were not significant at the 0.05 level. 4.1.4 DISCUSSION The most noticeable difference of the benthic biota between the Punta Manati site and the Tortuguero Bay site, a few miles to the east, is the dominance of the algal community which is probably associated with the exposed condition of the Punta Manati site. Most of the Tortuguero Bay site is sheltered by Punta Chivato from the predominantly northeasterly swell. Visual estimates of the cover of the hard-bottomed substrate by algae ranged between 50 to 80% depending upon station or season. The relatively high abundance of algae suggests that competition for substrate space may play an important role in the algal community. Competition usually tends to reduce species diversity. However, algal species diversity was at least moderately high; the number of algal ---Page Break--- species found in any single 1/4 m^2.

sample ranged between 6 and 20. Grazing by urchins has been found to maintain high algal species diversity in other algal communities (Paine and Vadas 1969, Ogden et al., 1973). However, only a few individuals of the urchin Diadema were observed, all of which occurred in crevices or other sheltered positions. No other macroinvertebrate grazers have been observed in the area. The only other algal grazers observed were schools of surgeonfish, Acanthurus spp. Consequently, if competition is a major feature of the algal community and if the effect of grazers is minimal, then other ecological processes may be responsible for maintaining algal species diversity at Punta Manati. One possibility is the role of physical disturbance. If environmental changes on a time scale are roughly equivalent to the generation time of the competing species, competitive exclusion will not occur (Hutchinson 1961). Several factors suggest harsh, possibly seasonal, changes in the benthic environment at Punta Manati. The Punta Manati site is exposed to the predominant northeasterly swell and its accompanying surge and scouring action. When visited, the rocky substrate at Punta Manati was always found to be covered by a thin layer (~4 cm) of sand, which suggests considerable sand movement across the bottom. In addition, Diadema were always observed in crevices or other protected situations, whereas in other less exposed areas along the south coast they are often found in open water. The greatest abundance of gorgonians and hard corals was often found on rock outcrops where they would be less exposed to scouring action. With sufficient physical disturbance in the form of surge and scour, the domination of the bottom substrates by one or more algal species could be prevented. Further long-term studies would be required to test this hypothesis. Limitations of the Data From May 1973 to the present, benthic studies at the Manati site have been headed by a number of different investigators. As a consequence, the research emphasis has

changed in the course of this study. There are little data relevant to seasonal or other temporal changes in the benthic communities at Punta Manati. The preliminary portions of this study were necessarily concerned with general descriptive surveys of the Tortuguero Bay site. Only gross temporal changes in the benthic communities would have been noted in such circumstances. Studies at permanent stations did not begin until the terminal portions of this study, and with site visits only occurring on a quarterly basis, it was impossible to distinguish between seasonal and other temporal changes in the biota.

If the ultimate goal of any environmental study is the prediction of the effects of a pollutant on a natural community, many of the parameters which have been examined (species lists, distributions, biomass, diversity indices) in this or other investigations, though often necessary as preliminary studies, are inadequate in this regard. Distributional studies or species lists, no matter how complete, provide little insight into the interactions of their component species. Diversity indices are highly speculative in their origin, and their ecological implications remain a source of controversy (Fager 1972, Hedgpeth 1973). These parameters provide only a static outlook on a community. What is required is an awareness of the dynamic processes responsible for the control and regulation of natural communities. In order to predict the effect of a disturbance such as thermal pollution, first it is necessary to understand the mechanisms which maintain the organization of a community, and then how these organizing mechanisms will be affected by this pollutant (Dayton 1972). Several studies have shown that ecological processes such as predation and competition are responsible for the observed structure of many natural communities (Janzen 1970, Harper 1969, Huffaker and Kenneth 1959, Brooks and Dodson 1963, Hall et al., 1970, Paine 1969, Connell 1961, Dayton 1971, Paine and Vadas 1969, Kitching).

and Ebling 1961, and Ogden et al., 1973), ---Page Break--- 44 PLANT ASSOCIATIONS by Michael J. Canoy 4.4.1. INTRODUCTION The north central coast of Puerto Rico is bounded by a narrow beach/dune community. The mean height of the forest is 2-4 meters with coconut palms rising higher. The prime site at Punta Manati occupies a low hill just east of the mouth of the Manati River. The area is predominantly sand, consolidated beach rock, and limestone. Plant communities in and around the plant site are typical of the area from Palmas Altas to Tortuguero. There are four distinct major community types. Two of these, moist grasslands and successional "fence row" communities, are human artifacts. The other systems, the beach community and secondary growth mesophytic communities on the two hills are disturbed but more diverse. Mango, Mamey, and Cupey del río trees occasionally occur up to 30 feet tall. The exposed beach and oceanward face of the dune represent a continuous attempt by plants to maintain themselves in a high energy environment. One of the worst things that can happen to this association is disruption of the dune integrity. This allows erosion to begin and the association to be washed away. 4.4.2 MATERIALS AND METHODS For the adjacent north coast sites (Tortuguero Bay, Punta Manati, and Punta Chivato) a simple survey method was used. Beginning 1/2 kilometer west of the Manati site and continuing 1/2 kilometer east of Punta Chivato, a transect following the coastal highway was covered. (See Figure 4.4-F1). Within every kilometer a 10 meter transect was walked on both sides of the road. The major vegetation along this transect was noted and unknown species were taken to the Mayaguez laboratory for identification. At the end of each sample transect, a one meter square was sampled for grasses, vines, and forbs. A common plant species list for the Punta Manati area is given in Appendix 4.4A. The area was surveyed for animal species, also. Appendix 4.43 ---Page Break--- “suoyaeyoosse queqd 105 Aoains woxe yaeuey eaund

“La-py"y “Sta nva20 DHNYAY 07314 TWwnoiss30ns_JS AS34804 DHAHdOSaW SW mou 30Nas Yd ALINMWHOD 34OHS/HOVIE SQ Tawny. ‘om 70 ---Page Break--- lists vertebrate and invertebrate species observed during the study period. None of the species observed is known to be on any list of threatened or endangered species. The species lists derived were smaller but very similar to the extensive lists derived from the study made at Barrio Islote (see Environmental Report for NORCO-NP-1), therefore it was assumed this method was qualitatively accurate. 4.4.3 RESULTS Generally the vegetation can be divided into four distinct community types: beach community, secondary growth mesophytic communities, moist grasslands and successional "fence row" communities. The beach community is largely composed of Ipomoea spp., Sporobolus, Kyllinga, and Remirea. This community is a very dynamic entity and depends on contacts monthly. To storm periods it may disappear entirely and return a season later. Beach thickets more or less extend from the mean storm wave level into the edge of the pasture and fields. The seaward edge of the thicket is about one meter in height. This increases inland to about 5-6 meters. A few coconuts, almonds, and Tabebuia reach 8-10 meters. Mesophytic growth here is typified by Chrysobalanus, Byrsonima, Guava, Cupey del río, with undergrowth of Smilax, Nepsera, Portulaca and Crotalaria. The beach research is typically dominated by Ipomoea, Remirea, Coccoloba and Lantana. Chrysobalanus and Tabebuia are developing 50 to 60 meters from the shores. Secondary growth is typically composed of human satellite plants such as Tabebuia, coconut, almond, and black olive. Flamboyan and Cassia trees appear occasionally and Guava apples have been planted. Around "fence row" communities of human habitation are bananas, plantains, oranges, and avocados. These plants should be surveyed for resident background radiation (total beta and gamma spectrum and total) prior to operating any nuclear facilities. n ---Page Break--- REFERENCES.

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“v2 62. 66T 66T @ ect zap Oo ML 6TO°T B341L N39Ax0 “IHD 6°87 BWiL SSIW 10 6cr62 et ta stroz at ta egtoz et 92 T8192 1h WL NS na et oot rad we a ee 21 a0 oD my s50°T 3LTL N39Ax0 9 xv WOT Tat “1KO wept 3WIL SS3W OtnoH 138 43M awa Auo ahaL et Gave ee 220 ws sz. aoz ast 3uIn 430 2 uswo et as <2 a Berm 630 1 asvo h 9tae-998 9n07 \ @'Teeer grat eu/tey to av now 3uva 220 3S19w9 CaNnIvd Ay 93 ---Page Break--- cust ‘tr how azo-va “ON os pnzy 37930 FUNLBNIeW3i = S FOB HasBOOUSIHLAMIE ---Page Break--- fez george teee "82 2p6rge 82°42 ---Page Break--- £062 ot 3Ty $9°92 er very ees 2t 70"y oF" Perla e012 vo012 TE TELIN Sota T/7K 1 OTS NITYS) SANE UW one N394x0 ae SHie30 GuvONYIs (ay 1e30 66" BOLOVS 733Hm 233K ys@'T B3LTL N394xO 2 STONY FEIN BOT M1430 XVK 1907.9 az “IKD T°? SKI Soa T As¥O BONO ANDI3M BAYH © Luv gno19 98 atanH Tau Sore o30 Simos Sa 1332 BAYH 8 dks anon] Ota Lam ana BvASNYEL 62 D34I0 ONIK Z AITBISiA~ Bez Aud anal S GOlWId NTR 9g D0T3N GNIN 2 USMiVIR S*9TeT Gord cv822 32N34343¥ ONud Stee NOLLYLS. 98 9NGT Tuy 17 now eerety 6a diva @ 381M oBKNTYE Ay ---Page Break--- sere zere oe Tree ete ore vere sore sere 82 ou't uae aa SoMa e a aera aet2 <a ae"? sot YeLIN SOKe ’ at xo709 6982 30 21N0s ydSNveL 9 oolmaa any ceveze vera eet9 rst92 229 unt92 ere 70'8 2hr97 #599 132 gern tre 85" 92 ena 16°6 aed erro 469 zoree es0 68"9 a 2e'3 a8'9 9 aera 18°9 ad eore 189 op'82, strc iets pty tot92 6Br9/ 22°89 sty uet92 “6°S 18'9 G2" BT"92 StreG 95'9 aa» ogrc2 AYSe VOW VK 1 Ors N394x0 68" 79Nv 3utH ese MLa3 E196 TTL aby gote2 SG itor ae'9 Soy B9'e? 98" Tot 88°9 zo"» ayrcz GOTT ca°9 Ry Lbtez Lysk 479K 77H I ors N39Ax0 166" ow Bony WIN get HLa3 4% ANOISH SAYH oz 62 93810 SAyH 8 #2 9N10 ONIM «8 ALINIBISIA a-G2 AHO dw3L £2 30734 ONIN 20 30N3u3438 ONMe eae ese paz ast eat se 8s 2 es carne e Ba6"Gp 90rL2 er 966°SS SurLe a SH1g30 GuvONNIS eee 82a Gry SS4CT gare EovcT OT R62 OME S199 Tyrer Teret et coz ace 99°96 2c'6t 2er63 21 Tez as sean 92°22 o2tz2 2-22 Tr 9 est NIWS 3A¥L WL LNB BL BD awa cy 830 OLOVs 733HM WIL3H GOT BIULL NIDAKO OO KYH

9¥907 222z “ind y'2 BWI, SS3K 2 ASYO vtS:98 264y2 goro 26r¥2 oT 4s eat BLT “8°99 89192 go's 09192 eT 26 ue BS Gee: Lo+c2 go'a cars? 2 92 S22 966s Se°42 co'ez orc2 TE 9 8g NIWS BAN, UWL TL we BL go Sum 3h (wy) Hida) OLD¥4 T33HM BILZH HSO'T YILLL NI04x0 0 X¥H 1¥907 Sst und BT GHIL SS3K_T ASV AKY 0079 9a GIKNH T3y 2 9x07 Beal on072 "8 1aK awd Wn non wanLyan Teter ova eu/ety se LV DTeWhd NOLLYAS ze 3SIN¥o OBNNTWE Aw 7 ---Page Break---

gate gat 203 g2t WHLIN SOHa ae x0109 eae 430 DINOS wrasuya > aolwad anew zeveze aera t6r9 pare 9) ans 1659 GOry HErEz pei2at :6°9 vate gvtez SP'20T 46°9 SB"% pEtEZ AYSK T/9K 77K LOIS N39AKG rrr B09Ny Gate Or Le § LKOIaN AvH e Ta 33810 3ayn 8 67 23st0 ONIN @ 2 30134 Onin ze 3ON3H3438 ON4e seerge 33702 er eLese acrez 8 Shid30 GuvONNIS —_zzy Gee 666'Ge TT+u2 ape Tr-cz 2t et er et 6a'ge azt42 aztce aerc2 tT a 88 NTWS Sak “RL UL NB BL 20 Sut onan ow Hia30 OLOVS 133MM 33H ¥S9°T HILT. NFDAXO I xYH WOOT Pzay “1nd HrEe BWIL SSIW T is¥D AW¥ GNO72 49a GI4NH 738m 9" EE=998 9NOT dk, 00079 O° 3k en3L ON Ltez-BT Lv ALT atStA a-gz Ae ewdL prs now NaMLvaM @-9teT NYE cu/TIY Ge YG Yee¥ne NOLLVAS 828 3SInwa OUNTYE Ay 98 ---Page Break--- &e e es ee pore anise zt fe'> ovter e sHig3¢ GuyaN Slr 2a gee 66°52 ot eer gor - as as 62 2 ea CHIN Sona ML Ne 20 31m k3L uy Hi30 £66" MOLOV4 T33HH 99434 N39Ax0 © 310 IN gut H1a3G x¥R 1907 eeaz 1 8S3q T is¥o Ho102 ¢ JHOT3H 3avm yy gno12 age W738 om ct Epe99e 9NOT Stro aa0 3tn0s ta ‘38u0 Baym ft gn873 @ 3M dw3k ON TERSAT L¥T UYaSNvdi yd D4¥10 ONIN £ ALIMEISIA are2 40 ghd G8 now S$ QoIH3d JAVA ya 073A ONIM 29 MBKLYIH S*gTaT UVa Ev/ety ge 31¥0 Sers2e 19N3N3 43H INNS @2-vus NOLLWAS 920 3SiNu3 OBKNIWE Aw ---Page Break--- griy Berg teyr9e zocer ear 168"98 g9r6T ese ra9798 eae zeu 96 ect Tos98 eat ree-9e 4 gee-ge as TPe' 99 —_ aE eter9s e pau-9e et 966"Se @ SHid30 CovONVLS oe e2e Teb-9e 26°LT Go'e Ze'eT eT 1462 ene gue “65°99 B9°3T Bore goreT eI coz age es ve9'98 Terue gore Toc2 Zt eT2 22 202 Go's 20-y gcge Specgs carte Gertz Go-c2 GIB eee Bey vow VW LOTS NIWS FAL ML UNG LB) SHIH

N394xo we oy H1e30 166" HOLOVs 733KM ¥3L3K HIM ave H.g30 xvm W907 aete 7 M3LEL N39Ax0 g°t Skt SS3H 2 AsvO TwS'99 de'¥2 Bere Be's2 oT Tet oat eet Gperse 22°92 awa Bet9z eT 9S BS OS ctwr9e co°e2 Oa" Le'ce 21 82 2 ge Brae 966'se ¥BrL2 Her L2 vee tr eg 8g 9K WK LOTS NITYS BAN, | Kd N@o 21 20 elm N3OAx0 dnb cy Hie30 66" NOLOVS 133HN W313H 968°T Y3LTL N3DAXO 2 Fwy wim ast Wig3C xm W207 saz “LHD OT SKIL SSW tT is¥d o 4OI09 of IHDT3M an¥Y LY GNOT2 “ee OTKNH 13H mH 9*Ee-908 9NOT e489 @80 JINOs pp 93817 3nve @ 3gai ONO] «BTA Lae add LIERSBT YT BydSNvHL 62 D3HIC GNM L ALTTEBISIA 2-gz AHO gh3L oho non © ontwsd 3n¥N 72 00734 ONIN Ze MBkLYIN ”TeT © GHYa «Su /ety Ge AYO 90992% JONINTAIM ONHE D@-vae NOLLWLS 828 3S1nyD cgHNIVd A a 100 ---Page Break--- ---Page Break--- ---Page Break--- Sauron ereze e SHid30 GavONviS _ 99y 920 sagas go-et easton 20¢8T 62 uvz ase Faeroe Cotee “et eet oz 6a8"99 38°22 “etext “est 605"99 sorsz 6866 Bet a SoT+9¢ 62192 eS ae as Seur9e c. 92 sz sz snd-on o5rc2 ae NEWS) SARL N39AX0. cw) M1630 £66" OLD¥4 T33HH B3LIW HSE H2LTL N3DAXO @ 340Ny SUIM aoe HLg30 XH TV907 etas “ind Frys SKIL SIN T Is¥O ar wo709 nH 738 =998 N07 pera 430 SINOS, im eka At Ly ~ BvaSNYEL © O91N3d 3AYH 9g 90734 ONT owve = cesty ga BuvO voyeze 30049249" ONNe De-vad NolaWss 820 381049 OBKNIS Ay 103 ---Page Break--- rete gure m8 REZ 2's oe nasa ere YeLIN SoHo 6 a2. voteg 9209 03u 31N0s ~—evasNYeL © antesg 3am covazw aera vera 6219 o8'e eprez 8°9 BU"b bere? verter <o"9 gate artez Sy'TOT pe'9 GL» verge LYSK Von WW LOTS NB9Ax0. 466" MOLDVs T33HN BILSH Flow WIN at nla 5 a a a iMgi24 aarH D3u10 Gaye 8 D3e10 auiy g 2073A auim ze 30N3H343H ONme geese curee 680'99 Bt-2z, Beorse fe+02 gare susan O5e42 eTh22 Brtc2 TT NITe er e SW4e30 GavONris a eerce at st at a @ GAL aE oe BL 20 nad On AL pS0°h USL1L N394KO OO x¥y 7¥O07 GeTT “Ko grgT SKIL SS3n Any ang39 34ai on973 ALDinargin HSHL YH Veevnd NOLLVAS 92a oLWnh 138 ae Lae awa 8°62 AUC GWIL Suter CHve # 9¢t¢-994 N gtez-er Beer Se/Tty 6a oy 920 or 2 Buln 430 Taso Ye 9NO7 an unk 310 822 3S10¥9 oBKATNd Ay

108 ---Page Break--- Teyeze 30N3¥3134 ONwe ---Page Break--- ---Page Break--- ---Page Break--- yeiin SOMe 2 ar yo709 este 430 I1N0S _ ~ ayasNvaL © goly3e 3nvs ‘yz epston vise eer “itp 22782 Se 9euroe 99'92 e6 PIB9¢ 66°92 es Lo2'98 GB°2z _ a Souroe cutee ar sao"9s 60°42 e SHid30

GuVONVIS ez ze gpraut 46° e° so'cz ot 96 et Bet TeTaT a6 Wr Be 8s GL: 20t ve" az se 2 sor2nt 96 g eo 8 @ LYSK V/9K WK LOTS NTT FL 29 Balm N39Axo. Oy H1a30 66" MOL2¥4 T33HM 33H pSO"T Y3LIL N3OAXO FUONY BBIN Dt Hig30 KWH TOOT eZRT ‘1A C22 3HIL SIH T LS¥D © NoraM GAYH c_4H¥ ano79 orane 73e ‘N07 ze 93810 3AvN 8 3e41 ano1D 136 g83L an 6) 3ST OWI TO AITTIBISIA Ore ABT dw9L nok 89 073A ONIN W3MivIn G'esor ONY fu/Tty Ga 31¥0 2uye20 3ON3H743E ONME @6-vid NOLAWAS ze 381049 oBknayd Aw 108 ---Page Break--- SHLd30 GuvONvIS 29% eze © ezct» 962 e6z eae @ screT $ cr2 oez esz @ srraz 2 he ost goz @ 6trs2 tT get eet act 2 29+¢2 9t aT got cot _ — @ Byis2 cr 4s ae as Te'92 ga'e te92 2t ye 2 ge area var : atece atede tr2 tt a 8B YELIN SOHe Lyx 479K 1/9K NIWS BAY “RL 51 NS 2120 Sut N394x0 awa (4) Higa 66" wOLDV4 T33HM_¥IL3N ySErT YILLL NI9KKO S Bow 38IN gue HLg3C KYW WOOT Lea ‘Lhd 9°2T 3HIL SS3M TF LSVD a ¥O10] ¢ IHOI3H 3AY¥ Tt LAY GNOT2 ZB GTKNH 7344 S*ee-998 ONOT 270 430 DINOS ia 93470 3AYH 3dal anor] ee Lak gwSL ot. StTE-BT LT — - “BVaSRVEL ~ 93-—T3ATO ONT ALITIBISTA AUD gaat ret nO % Gotead 3n¥* 22 20738 ONIN Ze M3MLVIN BTOTeT — CUYE —Su/TT Ge GLY. 2ove2e 3ON3E343u NKE DG-vHe NOLLWLS 920 3S1n¥D OBKNIVE Aw 108 ---Page Break--- os-vaa On-vna st oz “930 3unLyYadHaL a st az $3084. HdBBOONNIHLAHLUA ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- Toe voty votez gusrst zorsz et 20'e 067% G82 Gor'ce T5'Se e - — SHLgIO-DUVONYIS” ~ Tes ene TOL T6"y p9tez GeStce Zs'Gz Gere zorczz 6 Bt OT 28°c a6'y OG G2 garrse T5162 e YULIN SOME

AYSK VOW T/T LOTS NEWS SAV. KL ONG BL 2D uN N3DAxO awa cy 1430 466" MOLOVE T33HM WILK GOT YILTL N3DKX0 @ Bony 3YIM OF HLg3C XYR 9¥907 OTE “LKD C°OT KIL BSI T Is¥O ANOT3M 3AYH -& HY Ong) wor0a Yee aia DTNOS vasnvu. 4 GoTwad 3AVK 073A GNIM Teoees 3ONINIIIN ONUE VFevWe NOLLYAS 719 12 arce 13K awaL uve = va/bey ta 3LVC fee 3StnuD osNnTvE Ay 197 ---Page Break--- ates were 96e ote: 298" ar9" 908 286 su6 SHid30 GavONYIs —_ze9 ena ee es Bese Sh ce 8s zersz2 2 be se & aug" se greet 2 28 8 NTS 3AM KL TL NEBL 2 BIN dnb w1a30 £66" OLOV4 T33KM BIL3N 99O'T WILTL N3DAKO @2 FTONY BUIM GOT HLg30 KYM WDD OyGt ‘und B°GT ZKIL SSI T LS¥D - wo] LHOIZH 3AM of LaY GnO1D @z@_GtANH Tay N07 bere dd0 DINOS “ge O3uTO-3AVK G 344L GNOTD «g'zz 13K HII a7 wrasnvas D3u1d GNIM ALITGISIA AMO awl get nox 4 Gol¥ad SAY 68 9073A ONIN zs UBHLvaM Grater Ouva aevoz7 te Suva @ FONIN343N INue @t-vkd NOTLVAS 888 3SINYD oBNNTVE Ay ---Page Break--- eeree vite g9'92 atty go'92 vty a8'92 vety BL'G2 6e6 oc's2 gory Letc2 sz 26y o9'cz es B6'y ot'y2 ee 26" y 60'sz ez 26 Lo"s7 et Soy cose 2 SHid30 OMVONYIS e890 Geo a etty g9'9z cev'oe LO'LT Bato CoLT » gaz <2 aE a Shee 26'S Etty Z6'92 SENT 9E Stet & eee 9¥2 OGz a 26'S yt'y S3'92 206+98 asez 2 9 Let BAe a 22:9 serv aL'sz eco'ee 2:22 tT tet Get ast a G22 Trt6 siz zeetse Barsz oT 888 BUT a $2 26'y ae's2 Bsarcs €c'92 at oy as BS a 22°C B6"y Lo"92 Bczt9F gprs? 2 G2 62 G2 WO" 6%» L9"S2 GcEtGe fyc2 tt ao 9B veLtn vWF LOIS NTS. ub N@ 24 20 Bele N394x0 3k Oy Hie30 66° woLovs 133HN B3L3K Oye°T YILTL N3DAXO Ot STONY TWIN ave HLa30 KYK TV2OT Eees “LHD Gr8z SAIL SS3H T LSvD wOI102 sy AHOI3H 3AYH 2 AY GnoT2 zz GINNH 13H BT ¥e=998 9NOT Gye 430 DINOS gg 93uIC BAYH 8 Gadi GNOID "7k 13M GH3L oN BTZE-eT YT wydSNYEL — g@ D3uLO ONIN < ALTTBGISIA ABC awl 902 enon & Goldad 3AVH Tt DOTHAN GNIM 2@ —H3MLVIH G*BTOT ORV «bu /e/ Te 3L¥O fe9ece 30N9Y3I3u ONes Ot-vad NOLLWAS 82 3S1MD OAAIE Aw 129 ---Page Break--- byerse t5's2 or ag0'se To+cz e SH1d30 GuvONNIS ots ate kv'gs 26" Grerse TS'G2 8's Totg2 2 at et aT a'L6 g8'9 92" zeerse To'S2 ge'D

Te-c2 tt @ oe AYSK VOW VW L918 NIWWS GAY KL LONE BL 89 GUTH N394xo dn3h cy ued) 12 252 ce Oe abe wares 466" HOLDVS T33HM UILIW CPO" YILTL NIDAXO @ 379NY FEIN OF HLd3C KYW WOOT hE LWO CeET SHA SS3H T Ls¥D vor0a AHOT3M 3AYH 9 Lav on079 eae 430 DINOS 79 UyaSNVuL € GolWae aAvH © OINMH 138 eteee99e 9NOT 213M gw. NL62-BT YT @ Aw gW3L areT non 90734 ONIN f20T OWYE pu/O2/ te SuVO veoece 3ONTHI43y ONYE YeeVHd NOTLVLS £8 3SInYD CBHNTYd Ay 130 ---Page Break--- TGr9ox thie ets zetez eeLise gar 29'Z0T 2T'C 86'y BB'C2 ERE Ge se 96'9 es 69 er 969 ee 16:9 at 669 a SH1d30 ONVONNIS 9 Bee tore orte 99'S BO'2 9y'Gz gt 25 eat Bot 96:9 cote 9:62 gare a9'cz at be eg as s6'9 sere Gr's2 ov'e sy'cz zt Gz sz gz 65°9 Gath S668 cy's2 00 Lerce TY ook VOW VW NIWyS GAL Wi ML NG BL 2 dat N494x0 dna ny a3 466" wOL2V4 133MM H9L3N pyO*T HILTL NIDAKO @ B1owv Sun @at M1430 KYW 9V907 BzET “LHD EBT BHIL SIH T isvO 4O102 of LHDIIN SAH © AY GNO19 889 GTKNH 73H HK Bt EE-998 9NOT zete 30 DINOS 92 234IG 3nVR 8 dai an079 2 2M aW3L ON StTEAOT LyT uydSNvuL —g@ D3NI0 ONIN ¢ALTTIaIStA EO aw3L rer nox 9 Golwad 3AYH TT 2073A ONIN 28 MBKLV3H G*@zeT OMY tLVBzv Te Gu¥O yy9ese 30N5U3234 ONne 82-vag NOLLYAS @e2 38InYo OBNIE Aw 131 ---Page Break--- stiee aprec gore 2606 vers 2e°9 anes m9 s2teot 2: scot ts'e TEeT vate a2'eot 96'9 zt ettee arse a9r28 seveeeetc'9 49566 49"9 g9tcot Te'e 65165 £6°9 ezect eo+9 AYSK 9K sere 20°9 ag gy some sty aety zety sory ao'y arg g2t6 a6» 92"6 a very WK NB9AxG @ ony gure wooo ¢ iHoray yete 30 DINOS c9 O3¥TC wydSNvaL Dautd 9 cotMae 3avH 20734 a Sy9eee 30N3¥343u ONNE arioz 22192 te'sz etree vetez sere tetee oute2 pctee sete? te'e2 ayoz L292 rad sare yeree terez scree ated iors tot wi aan 3aTN Nim Nim aa z a “ 20 gystoe o6ter ac'9¢ oer6t 266°98 £2452 gectog Tot8z 5"se 02452 99°66 verge Bacge 22782 204" 66 vy? B69'6e errs oy's2 6r's2 SH1d30 OBVONYIS goo ota 9yS'98 96°LT BO'D 96'LT » 2 Bae Bue acc'9p 6E'6T Gate BETES eB Bee Use 66°95 $2112 Be'g F212 2 @ Bde Boz ed'9¢ Od" g's Gee tT @ act ast Gls'G8 O2'62 0°D Oz"<z Ot 46 GaT BET GaL'6¢ L2"62

fod L2"G2 OT @ as as LeLsp ays2 Gree av 2 sz? 69°60 6y'G2 Ooo Byrcz Tr @ of NEWS 3AYL HL TL NB 2k 20 Bed 3a ony 130 OLOV4 33HH B3L3H CharT UILTL N39AXO JO XYH W007 S gt “LWO T:az WIL SSI T Ls¥D 4WY GnO79 gaz GIWNH 734 © -m 9teR=998 DNOT dhl ONO19 8°82 19K wWIL ON COTR-eT L¥T ALTMUBISIA O° 4eO awaL Tree now WaKLV3M G*eTBT ORY pu/8z/ ta 3.¥O 22d NOTLYLS. Be 381NYD OBHNIYS Ay 132 ---Page Break--- £ 26t% 9 90" BLeish ooisz Zye'se vytsz eri tet &% 62566 sHig30 GUyONYIS te ete gate 35" gtrtot sore ze'y were acdgp bytez Syisz oF ot et at 8°2 60" 61466 s6°9 9Rty BL*C2 ZwL ¥yTEz veraz at 2 8 8 YULIN SOMd ASK /9H V/TH 1 OLS NIWS Sava RL ON BL do Qu Na9Ax0 wa cy Hue30 66" MOLQv4 T33HM_BBLIN pPOrT BIULL NIDAKO @ 31ONY FEIN OF HLgIO KYM 1¥907 BGK “Lhd O'HT BHI SSaR T AS¥D WOI10] ¢ AHOIZH AAR 9 AY GN012 Ee GINNH 73Y MH L*ze=998 9NOT zea 430 21N0s ‘Q3N10 SAY 8 3441 CNOTD a*ez 13K gk3L oN -G*E2NAT 17 wy dSNVUL. D3u10 ONIN 9 ALIVIGISIA @'A Aud aw3L ET ngs © Golwad 3AYM 98 073A ONIN 28 M3MLVIN EzaT —OMYE —ru/Bzy Te GiVO €298e9 | 30N3N3430 ONwG Yeevag NOLLYLS 8 3S1N¥9 OBHNTVE Aw 133 ---Page Break--- 996"5¢ 99%G2 erg ar 2 vse SHid30 CuyONrAs c9'9 38'y gorse gorez oF “e9 bete asrsz 89:62 at zy 96°9 co'y 2562 ze'ce zt 62 eat Sere gery cree ceesas paces SOMe AvSX T/9H S/W LOTS NTIS SANE NBoAxo ayo ese eer gat as as 2 a 29 un Wy 4830) 466" wOLOVs T33H4 BFL3H fyasT USLTL N39KKO @ STONY BBIN Bet HLa3d KYW VDOT Ores “AMD BrLT BAIL SS3W T AsvD woI09 f AH9I3K 3nYM 2 any ano wete 30 DINOS “Be O34TC 3AYH @ 34A1 ONOTD UyaSNveL gg -D9NIC ONIK ¢ ALITNeISIA O1AMH 134 9tze=998 ONO LK dW3L NW ORERT LWT AeO an3L arct ynow a 9 Gotdid 3AVH Ft D073A GNIM 29 © MSHLVIN g-TzeTUVE «buvezy te JuvO Zv9ecg 30N3W343¥ ONwe @e-vad NotLWLS Bee ASIN oBWNIYE Ay 134 ---Page Break--- aytoz stt92 sercz es'9z ot¥ 98 ey'sz 929'98 g3'92 98898 ge'62 T2099 f6'h2 BTR ei82 ase'se cie2 eal se fete co “e722 a9d'se YULIN SoMa 2918 NTs 466* yolov4 133K" ¥313H @

Fon aWIM gee H1430 XW O10], AHDI3M 3AYH oF _Aky GnOTd zara 430 DINOS $8 93¥EG 3AYM @ ual GNOTD vaSNvaL gg -D9NT0 ONIN Z

ALI TIEISIA 9 Qolu3d 3AYH TT 073A ONIM Ze uamLVaM Syoeee 30N3N3434 ONNE Dgevad NOLLWLS otter SHid30 OBVONYIS ae'e sttet 96 gee vores ve were 2ttaz 2 6t eeve at a0°8 Tet as 62 @ SAV a a s*2zer OIWnH T3u Castlarrs ry ANC awl g+8t ouva wy syert 3111 N3DAKO W907 Bayt “4nd cret 3WIL SSH M Cizes99@ OK N ctte-eT veseey ta Be 3S1nD CBHNIVE Aw s99 sto ees 2sz 202 act ent as sz @ 3atm kig3a Tasva non 3uvo 135 ---Page Break --- set ot" YeLIN Soka woroa eae 430 DINOS Urasnves © Colusa 3ave egteot otter agtaat attat ASK a6'8 0's 26'9 sere 9K sory 2'6 oer zty WK NJOAx0 stony 3u1m © ee 62 ve AMOI H 93810 Daata 073A pers veer vere: oan: 11 466° ar anvn 3am ants ant oegeeo 30NIN3434 ONMd Mia! , 6 9 ze 2 z28'se anise ar 2 OLe'9e fH e SHid30 GuvONNIS 989 ete 2 eee'se er's2 ao'a Gyrgz 2 tt oT Bt 2 Oce'9e SerSZ aoa yg2 TE © 8 B S NIWS SAL ML UL NB BL 29 3eIn dna cay 1638 MOLOVE T33HM U3L3H Geet Y3LIL N39AX0 30 XYH WOOT 9TBT LHD EtwT BL SEEK T LS¥O AWy Qn012 gee GInNH T3Y MH 9" TE=998 9NOT Beal On079 avez 13K gHIL oN Stez-BT AT ALIMeISih 9°8 4HO gw3L tot 0H MSHiVaM G*ezeT ONY su/ézy te 1¥C VoevWd NOILYLS @e0 3SIN¥o OaKNTVE Ay 136 ---Page Break --- B19 sety corer re:9 96:82 oer9 tersz 26'9 futez £69 tevez 96°9 969 are geree 9a: tere2 269 9679 zeree » Tarcz WoW VW L ots N394x0 we’ VaLIN OMG zee9e soa'90 sta-98 suerse peers ToB'se ease reo98 st0-98 O98" oe “e860 NEWS corse e9ee 69752 29'62 ard 9°82 39'62 ugsz 6982 a9"s2 T9662 BAY eer << Bs es ez at @ SHid30 GuyONv1S aes oF Gero Lstsz gt tL 66 @e'o 49'62 BT es as gore agrcz 2t cz 52 geo t9:c2 tr ee 3 Who UNG BL 20 Sutn Waa (oy) 830) 466" OLDYS TY3HM U3L3H SPOT WILTL N3DAXO @ FMoNy 3BIN Bot H1e30 xVH wo10]-¢ AHDIaM GAYM £ _Aky gnolg. z0Te 230 DINOS ge D3UIG 3AM @ ead Ono? BvdGNveL ga -93uIG GNIM 9 ALITUBISIA 9 colwad 3AVK Tt 20730 GNIM 26 w3KLVaK veges 32N3u343¥ ONME @pevad NOTLYLS 207 2tzt ‘ind 2°9y BWIL SSH T ISVO 892 OLWNH 134 Ztte=998 ONO e aK gW3L N-¥toReeT LY? AEC ge3L 2c 9 now zat OUVE bu /8z/ te Biv @e0 3SIn¥o oaKnTE Ay 197 ---Page Break --- ar'92 cest9e aareT Th £8192 Lad‘oe @2'6T

ez 98's2 2z6'9R s5't2 eae iT'62 99ctog corte est 6erez easese cctG2 eot 2ere2 e9e'se ¥9'52 se 64182 pae'se 5°62 es Terese zaerse Sorce es terez zae'se 25'<2 22 tere2 zaerse Se"c2 et ee's2 2e0'se a5+se e Shid30 OuyONYs fy'9z 296'98 caret gute catet y 112 462 ge192 cactor gzt6t Beret ¢ $82 oce 98:52 2c6ron S5tt2 s'32 20 8 ane LT'G2 gecton e952 fyez t @ ast 6182 aesrce Scie? eis 9 @ das 2:02 vae-se 15162 isre2 at 9 ag Te'e2 2aarce 26°<2 2erez 25 ae st GretoT co"4 £6" BUr2z zaR'se 5°62 6:52 tr a8 nyse WoW VW 191s NTS AML at NB 2L 20 N394x0 ay 66" wOLDVS T33HM BILH PyATT YSLTL N3DAx0 2 SNONV 3BIN @OE HLg30 KYH T¥DO7 cat ‘ind 6°9T 3KIL SS3H yoI02 «> AHDI3H 3nvR THY Gn019 ged GIKNH 13H BF te-99% 96f@ 430 DINOS D3uIO BAVA 8 3dAl GHOTD G"92 13N GHA ON Et 2E-aT ydSNVEL 9@-99BI0 ONIN L ALITIGISIA 8°@ AMO GH3L St9T 9 Gold3d Save TT D073N GNIM 28 u3hLVIK GrzzaT OMY BLvBRy te T9982 3ONINI43Y ONNE Ovavad NOLL 99 o80 ous asz eee est get as <2 @ Buln 30 T asvo 2 2N07 an nn uve 28 3SINND OBKNTWE Ae 138 ---Page Break--- rete vi vocige terse SB'y perc? p2eSe Gyraz gate et ceraet 20°C Téy ve'cz vaLiGe Tetsz aa'e 60" 2/'66 £6'9 GBiy vErE? HZu'Ge Br-cz VBLIN SOME L¥Sk 79K T/7K LOTS NITYS BAN N39Ax0 er e SHLe30 DeVONYIS Bo eee aero twis2 ot gt et aero aerc2 at tO Wi NE BL 29 nah ee (66° YOLI¥S 193HH 343K pert H3LIL N3OAXC 6 FTONY TWIN BS HLG30 KVR 1¥O07 EFOT “AND ovwT BALL SS3K Tt 1S¥D wor02¢ INOI3M BAYH 2 wy ono7D e200 430 DINOS eg 38TG SAH 8 3d OnO79 avaSNVL G2 93410 ONIN «9 ALI Tiers esvece 30N3¥343¥ ONMe Ye-vhid NOLLWLS . 9 Oola¢ SAY © 9@ 3OT3A GNIM 28 M3MLWaH OS" 6 OIHNH 138 Stae=998 9NOT 52 Lae dw3L oN StezeeT 1vT 8 AuC an3k oT now ezetoMve tu /82/ to 31¥0 820 381nud OAKNTVE Aw 139 ---Page Break--- to 66°9 gee'9e Lotez eer

‘6 98'9 eso'on 99'ez to aa'9 deuron 19762 te 2699 tp9az te sero agree to S619 a9+s2 ‘a sero re Ed SHid30 GuvONYIS geo eee 26180T 66'9 Gay Lorez Eee OR LstS2 BetD Lerse oT 1S 66 But arr yo'82 cserse 19"S2 Bo'o L9"G2 at or 0s as 42) stiaot co'9 98"» zerez Gperce O9-s2 aoe eorc2 2t a G2 G2 Bar eTegat G69 gAty

Te"c2 Tee-ge as'S2 aoe eorce Tr a be NSOHG AYSK T/9W VW LOIS NEWS GANL HL LNG SL BD Sure N394x0 awa Oy HLe36) 466" HOLDVS T33HM HIL3W PHOT BILTL NIDAKC @ STONY BUI BBT HLg30 xVM TV90T BGBT “4n9 B'S BHI, SS3K Tt ISvO yor09 AHOI3M 3AWN Tiny Gno1d Bec’ OtKnH 134 9taea998 ONT 28T@ 430 DINOS 23810 3AVK 8 341 GNOTD B"9z 13H GHIL «ON OTAESAY LY? UydSNvHL a4 D3BIG ONIN 9 ALTUBISIA @2 Aud gndL Ot oT now § Gotuad 3AVK c@ 2073 GNIN 22 H3HLV3HGtzezet uve «eu /eey ta SLO Be9eee 39N3N3I3u ONNE 86-Yad NoTLVLS ee 381N¥9 oAKnIVS 140 ---Page Break--- 982 6552 asrz vetaot 45162 ‘9 gate settot soarse acre ‘3 6a'2 9o'tat Toast 65°62 SHid30 OUVONYIS ~ oto eee get zetye sevt9e covey tote § $82 eaz gee set vetee aag'9n 96495 Bere © Bee Ore 362 a: sotae 2a6'9e Lotte UeTz 2 26% 263 Boz ot tras zecton R618 2 pst ast ut act6s. QT3+99 autsz Bcre2 9s BR ROT at: getter 26°68 65'62 sere2 oF ty Gy Os 6a" yttgot Bu8'Se 65'S? ieis2 2b 2 ve Se a¢ 9a'tat 2 roe'ch és'52 VULIN SOKe LYSK, NTs 3AVL serc2 1} 9 8 8 NG 22 20 Gutn (ny i430 Na9Ax0 £66" wOLdV4 T33HN _U3L3K ovOrT U3LIL N3DAXO GT ITONY IWIN COE —HLd30 KYK TVDOT ZeTt tLWD GrsT 3WIL SSIW T AS¥D wor) AHOI3N anvH AWY 0NO79 G92 GINNH 138 9taR=998 9NOT e680 430 DINOS 9 DFUIO FAVH @ 3eAL GNOTD "92 13M awIL NP TEMOT IVT WyaSNVEL 83 -O9BIT ONIN ALIMIGISIA 8°@ AWG @H3L 9ST unk 9 Goldad 3AVK 9 DOT3A GNIH 28 USHLVIK G'220T ONY = /BZ/ te GAVE 6s90ee 30NZU343u ONME DGe¥hid NOTLVAS ge 3SIND OBKNTE Aw ---Page Break--- Deva nWka 3e-Wka 3e-via fuse ‘ez Ken eno-va “on s8ynay oT Va { 3 7930 aunivaTaWaL az se az 3088. Hav¥SCHUSHA AMLYE sz az 142 ---Page Break--- + gt 1 ee WaLiN SoMa ‘ 49709 eau 430 91n95 evasnvas > dolysd 3avn vouep T6146 6919 goty eg'e2 zevige Gstvz 96'92 9stoz zB Bt AF 166 5219 Sut GstE2 Scg'sr f4'92 es'g2 Cgtgz T oT oT 8 AVS WOH W/1K LOTS ATS AVL KLUB 2D BTN N3EAx0. an CES 466" woLDVs 193MM w3u3K 949" HALIL N3DAKO Stow FeIN as mLa3C AVH WUT Bee TLKD Off SHIL SS3K TF 4syo. YanS13H gave «2 wy GnO12 eB Oth 73am LtyRHog 9NOT at 4sf0 Gav dal Gn019 OM 3k dada ON BhAEWRT YT at 33u10 Uuiw ¢ ALTTialgin

atez Aed awd C'S. wow 9 D079N GNI 24 MSMLYIM DYRBDT Duy wL/2z/¢—BLYG 3ON3M3474 Od votyag NOLAYAS asiNwo oBKntvs Aw 143 ---Page Break--- YuLIN Some “ 49109 22a 430 DtNos avdSNVML, » Gotu3d aay sour 9 ety ontce ceatge y SFie2 dees Gorez gorez setcz & tet 6s aot 2 92e'se 25192 2b 2 098. 2 2592 ¢ as as Bs zavioz 2 Gt G2 ge ‘92 ay'oz oy'92 tT og ft a AYSE WOH VAN L918 NEWS dard WL at? Ne B. Tay Sut N39 dna (ay Hue30 466" yOlovs T33HM w349H aco" ¥aLtL NaDAXO 379NV 3uIH aot TLH9taH aay 69 93u1G 3Avm @t 93utG Onin £8 90734 GNIM 3ON3UI43¥ ONE Mid3G xv WOOT 2 @ '4Wo ate FWLL S$3k ft asva 2 tay ono79 OtwnH 78 Zteeeg— 9NOT y Bask On019 © 8°g Lam awk oN SttEeas ayy 4 AMT, Otte Aud ah3, tg unde zo lw ‘ Ouve = pe /eere Gav arene NotAvas 3siMwo oBHNIVE Ay 144 ---Page Break--- tet ost ve! vt 93 vst sat 4a) VuLIN SOKd ‘ 40709 ete 430 21Nos dydSNved, > Golu3d 3nvn 99esh estye yater 682 “vite genet oe zetee 29%6t eat 94 6 bye @ 44tez 26 greg @ ast9z a Vow VW A STS NETS AYE a N39Axo ‘ £66 wOLavs 735KH 343K cet YaLIL N39. BIONY BUIM Gof M4g30 xVM 1907 42a “LHD wT SKIL S: © ANOI3K 3AVH 2 _dnV on072 26a OLWOM T3u 6@ 93410 3AVH > BdAL GOT «tg L3H an3L Bt D3uf0 ONIN < ALITIGISIA tye AYO aH3L a D013 ONIM 20 W3KAVN ThaTeE | OuvewL/ei 30N3¥3438 Onue OFeVRa NOLLYLS asinea 29 Wy #1230 Axo S3k Tt ASvD N07 a7 now 2/6 vO oennive Aw 145 ---Page Break--- ---Page Break--- ---Page Break--- asz “a82 ast - 2at 7 — $6. _._ ae 2 er e SHie30 CuVONYIS 4s ove Beret » 162 662 gue grat © GHz bbz

BGz “erst 2 6b gaz Bez 6ort2 Test get ast be'y2 oT @ oat aot W6"Sz Bt es es as yg oe Err £066 yo'9 acy certe cebres Bete Soe sear go YELIN SOM@ avsx Vow T/tW 1 91S NIWS aAWL RL a) we Sy Suu N39Ax0 da (ay Heese 466" MOL2VS T33KM U3L3H QL" Y3LTL N3BAXO (BURTON 3UIN gee HLd30 xYA 4VO07 seo “Ke g*2t SKIL Seam T isd yO09 2 LHOISW anYM Tay gno79. S7@ 430 Din0S g¢ 93uTG 3AM @ Sen) Gno7? ~ SVASNYEL~@t~ DUTT ONIN ~¢—AITTEBTRTA % Oo1¥3s BAYH ge 073A GNIM 20 uSHLY3M 49g OWN 73u ous vereey 6a 310 OScf0d 30N3H343H ONES 8-vhe NOLLYLS. fe@ 3SIN¥O oBKNE Ay 148 ---Page Break---

---Page Break--- ---Page Break--- ---Page Break--- Dawa SA98U1 HobMOCWESHAAHLbE ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ust “te 2990300 os0-va ‘on osfnay Deva oe-vaa orWad 1d se a st az 2 "930 3uniuaagH3L Se ae st we se az $3088 HebUSOHUIHLAHIBO ---Page Break--- ---Page Break--- Gort cat e6ie a! To arteiat TO'vs 2649 Gate tetyz 96196 12:9 ot» tote2 “I9tast Tete wL*y Tetee QS! Gbrtet 69 ya'y 2at2e 170 aw ~ VeLIN SoHE "uYSN TvowAZTH OTS 22 3utn N39axo 4K) 41830 —_—— ea tomy sare ppGOO BOLOVE 334K UIE3K— BIZ wITTE-WaEAKe—— ~— _- © STONY SUM AEE H4g3d xVA 199079 9 “nD TeaT SKIL Seon Asya Sonos fq {MQU3M AYR 8 aw cn079 agg OtWOH 134m Bt¥t-99 onOT 9eta-a30 Jtwos —Ze a3utG 3Aym 8°8 1am dnd, wot TEaT —u¥t uvesnved, 33ula GNin 8°62 Abo gu3L—T+at non SOT wae ane ——— TOTFA-OT S9ver ONVE —Fu7tevar —s1¥e — a zeees Bonswsale onag BreyKe NOtAVES ‘¥81Nwo OBHMIVE Ay ---Page Break--- #20798 Setst ¥6t gee gue ese ecz Bez Doz est act e 20 3am wy Hie30 N3DAXO ~ £86" BOLDVS 133M BIW “RTE UIE -WIOAKO MIO BUIN aut muedu KYA HOOT Eta stad got KIL 8834 T 1svo 40109 ¢ANo1aN 3AYR 9 any on079 ze@va 430 2IN0S 99 93H m8 agit ano7a uvasnveL 6a D3) ALTMersia -oord3e 3Ave $3. 30T3N ONIN 2B uSatyam OLWNH 73y* etye=99 9NOT A3hoda3L oN BttRORT LyT AYO dn3i ty now at ONY WL/TE/ET GLYCO fees 39NgHI438 oNUe ore¥d NotuvAS 38towo o@Nnrve Aw ---Page Break--- 26;T0T 2679 cary ooze cezrce gerez er 986 SOO GL*y S222 BONER 2c Ce e SHid30 GBVONVIS 92% ace arg gee EE.3T £6:9 S879 y9°z2 cease gerzz gore oeezz > tt ot er Feit Sma “P18, $852 $e59 G2222 wosree 2eece aoe seceg TF 8 YULIN SOME “ A¥SK 779K WK 1 Ofs NTIS) “SARS ON® BL an ew NBDAxO 0H) Hie30 666" BOLOVS T33HM B343H BTL! UaLTL NZDAXO 2 Nowy autN et M4g30 xvA TyD0T GG And BET MIN eeee asvo KONOD 4 :HOIaK 3AYH Z _Lay onoaa OtHOh 738 a*ee-998 onor QINOS a “9340 GAYN «8 34,1

gnowd Lie awl oy. sonra $2 28ulO Guim Alrtueisin arge Ako Suan NAS. 430mm 26 9073 GNM eo waHASM G*ZteT Oe SSTey ay ava ®26260 30NIu343u oNuG Ye-vid NOLLWAS 8 38InyD oaNnave Ay 12 ---Page Break--- SHid30 CUYONYIS 6s eg ra ger22 wer eoy aay 9892 & 9S as se 8 a eo tt @ 6 8 Tb NG 21 a SutH 1430 173 verte 1x Son 473k Toke Nagaxo Wah 466" wOLOVd T33HM U313K BTL! -HILTL NOAXO @ F70N 3UIN gat MLg30 XWH TVD gyzz “iM OZ BHI SSIN T As¥D 0109 AHOIIH SAYM 9 _LWY QNOT2 gg OINNH 738m T*ye=998 9NOT e9te 430 DINOS ‘23410 SANK 1079 13M gw3L | N-S*BRSeT “LY avaaNvaL 3u10 ONIN $14 2 ABO GHIL az non © aoluad 3AvK 20734 GNIM VIM L'2TaT ONY ge/Tos Tr Suv 686060 30N3N3434 NuE @z-vid NOLLWAS @c8 3SInyD oeNnte Ay ---Page Break--- treet T9892 e292 29°02 aerce $ar0z cared orr6r porte go'82 sere 20°02 Te0c2 3a 289" re Nts: eer ase eae est eet $e as es az at @ SHid30 OUVORVIS —ag6 age ae: 8 862 e62 oop ee'o < ez eeo 9 ust ea Sot % oT £ ts z 06 toe N@oz OH) Hiead foe" BOLE T33HM BILZH BTL! wOLTL N30AK0 S 3TOWY BUIN nk HLa3O xvH WOT EIZe «ima 2-2 LAMM SAD 3 aso 50098, 427K ave 9 wy conor sca tare Tay B'2e-998 9n07 obra se QINOS ge “23ui0 3avn gaan Gaeta gfe OND gWaL ON Steet iT ev dSNTeL 23u10 ONIm ¢ ALT THBIgiA 2 AW BW3L 202 on S coiuad 30H ye 2073 ONIN 22 uamivan goSSar Owe beter tr 3i¥a

@6ese 32NI¥343u oNMe Deevad NOLLYLS. 250 3SIN¥D oaKnrWe Ay 178 ---Page Break--- T6t96 39'9 ety gotzz 96°66 20°C 26" Ga't2 + T6'96 t9'9 coy Bstz2 PT T5* 96°66 20'L 26" 90'T2 YHLIN SONS L¥Sx Vow T/W 1 OTS NB9Axo 66" © 30Ny auIN Bt HLaRt 0709 ‘ 9509 430 DINOS ¢@ 93NT0 JAYM og avdSNveL ga D310 ONT » Golwad 3AYH 29 20730 GNIn 20 626069 39N3u3434 ONuE AHOIIH 3avH vatise core er £6620 voece e SHid30 CAVONYIS 626 aga verse 0642 Bare esrez 2 8 oat at 46°28 r9'42 @a'2 yercz tT 9 ogg NIWS GATL WL UL NEBL zo Sut dk3L On Hiead OLd¥4 193HN W3L3H ATL SLL NIDAXO OKYH AWOUT 2t6 'LKO Z-ET BWiL SS3N Tt is¥O KY CNOTD 988 OIKNH 13x Btze=998 ONO? das ON079 9° 13M GW9L ON Stez-Br L¥T MIMBISIA gr¢z 4¥0 an3l geet enon waKAWaN C'USaT Owe bu/tey at Gu¥O. Ye-YHd NOTLWLS es@ aSinys

oawnre Ae 175 ---Page Break--- ear Se 26 as 22 ar e SHid30 GBvENVIS 986 age re9 96 Bere sree» tet oor eat at 96 Ooo 9662s By as Be gore seruzz 2 gz ge iee-20 ere t2uzt @ 9 3 NEWS GAM kat ne Bn ag Sate nae On 41830) 466" HOLDS 133HM BIL9W BTL! BaLIL NZDAKO % ONY FutM get mLg3d xVH 49209 Laz “umd G°@ JWLL Soon T sye Siuoe $5 (RSI 34Ye any gn0r2 298 atninn 738°» e*zeeage 9n07 sete 430 21N0S 99 O3uIG Saye 8 aah Onoia ere “Tan ease toe-et iva Bye 82 93K1O Wim ¢ ALtTuBistA avez wo gual Sefe non % goltad 3avk 98 90734 Ohm 29 uHuvaH Geter OuYa ave, tr TOT 986e6o 39N3¥I43y ONMe AR-vie NOTLVIS 858 3SIn¥9 oBWnrVE Ay 176 ---Page Break--- Iee 22t9 zaree g2'9 Lee 22"9 “to agty baS6 F6t9 To'r6 86's SHid30 GayONLS ae ta ee pert os 25°6t ae asrt2 s cer82 £8 bore bute are vey rstc2 94: sez » yore 26% S2°22 Lg we SutLe oety arrer arte ote 296 2228 Gc'62 Lec+9p 26°52 Vik L918 NITYS) aaNL N394x0 468" wOLD¥s 19344 ¥313H e BUI 90s Hig: sgt att 6'9 say aztcz otto eat 8's oc'y 9etez gee ga" GL'9 22's 2t¢82 sete set SO°C 26'» Getz YeLIN Soxe 9K HL OTS N39Axo 2 sony gen ¥0100 ¢ LHoIaH aeee 230 DINOS §@ 3uI0 uyaSNveL ga O3uTG Goluaa 3AY# a 2073h OXY VDOT LEtE “Lhd O°T st ve s) Nis 262 ave vst oot 2 zoe eee eae agt rat se 96 or 22 er 8 use ose eee oor esz ase edz 202 eat act 29 Jat uy 1630 @Te+ ¥3L1L N3DKx0 BHIL SS3N 2 ASYD 2182 go" L282 » got gat oat 192 ao'2 aer92 eas as as e142 BO LUZ 2B Gz G2 oe scat 9 8 8 BAY, kL LN BL 29 du en3h (4) Hid30 ABC U3iTL N3D4K0 466" wO.dv4 73344 9313K eet mig30 xYH ¥9 BAYH § _Lwy ong72 BAYH 3441 0no79 ONIN 4 ALTTEBIgiA ONIN 290 w3KAyan 2e-vae NOT 486060 39N3N3434 ONNe ur gete + tee a saz ercter as AnD pT 3Wi1 883M Tt is¥D THM 128M 6*Ze-990 9NOT ABM dW3L ON B*TE=OT 1¥T ROO awd CT now owve pastor tr 3uv0 60 3SIn¥d oBKnTWs Ay 7 ---Page Break--- sere 269 BL ¥ estze v8'y U9'Te £89 oc'y est2z 26°9 v8'y 19" tz S/W 7H 1 91S NJ94x0 VELIN SOMs 66" @ 359Ny gure mas 40100 iMOIaN SAYN & tee 430 DINOS Ge O3utG SAY 8 BVaSNVHL 6 -D38I0 ONIN % corwad 3avH 28 20738 GNiN 20 26269 39N3¥343u ONMe a actise 69rcz et 20888 69°42 a

SHid30 GUVONYIS aes age Bet'ch Gercz goo Betz» 6 ot at zigree 69°42 ao'e egrcz ee oT Bg NEWS GAT WL ONL NS ok 2a Sate dna w) H4d30 OL0vS 733HM YBN ATC? LIL NIDAKO 0 xWH WOOT 286 “1nd ¢'ET BWI SS3W T usva AkY gNO72 98¢ GIHNH 13Y M ette+99@ ONO? 3da1 0n079 8s 13K gw3L oN Brezser u¥T ALIMBISIA 8°92 AHO KIL 5*ET unow WIHLV3M L*“TBT ONY pe/TEY eT Si¥O Voevkd NOTLWLS 68 3SInuo oBKNTVG Aw 78 ---Page Break--- ahicz cterog s2tez Qetrz assr9n 99162 9uts2 ape on 15192 80'22 eedise 69912 28°22 popes 6ct42 $9122 eze'se aatce Grr2z aces 20°42 SKid30 OuYONYIS te o¢e 3162 eter9e Gzrkz ee'e Gztez » eet Bat gET 26'9 28'r 94182 eeEt9R Lery2 Bo'a Letoz fF fs eG BS e919 L9"y $6122 GagrSh GL'L2 Bato GL-L2 2 8 Gz gz 26°9 vO"y Ov'zz arene 2e'L2 BB zeU2 tT @ 8 3B Von VW LOIS NIWS SAVE HL LON ZL zo UTM NB9Ax0 ana (ay 430 466" wOl¥4 733HM B3L3K @TL+ H3LTL NBDAXO 9 STONY IWIN aay M130 KYW “WOOT Szaz “1KD pre HLL SS3H T LSvO 4O100 § AHOL3H JAYR ANY ONOT72 Sea GINNH T3Y om Lt TEe99@ ONO e43e 430 INOS «Ge ONTO ZAVM «8 dks GnO1D «Bt LIN GKIL «ON OteESeT VT WYdSNVEL 48 D310 ONIN -¢ ALIMIGISIA @¢2 AMC

GRIL tre, nH y Qoiead BAVA 98 D0T3A ONIN 20 MEMAVIM «C*CTET © OUYE = bu/Tas tr 3LYG S86060 3ONINI43¥ One avevie NOLLNS so asinu> ceHnive Aw 179 ---Page Break--- SHig30 GUYONYIS" £6 a¢e seet9e ered @ 62 662 gee ots 98 Eros ¢ eek bez sz 669'98 Soret 9 96T 64r Bar 96c'98 t't2 ¢ tet ost est 456198 8trez y 68 BAT Bet vit9e oraz s 89 as as reese sce 28 ge ge S6"7 97°22 ors-ng seuzt a 2 8 YUAIN SOMA LYSE W/9K 37TH 1 -9IS NITWS, ATL ONG FL zo Bere Na94xo oy Higad 66° woLovs 133HM B3L3H BTL* wILTL N3DAKO y ROMY FEIN ue HiLg3C XYH VD0 get "1nd O'S? 3HIL SS3m Tt is¥D O10) 1NOI2M GAY 9 uy ONOTD 648 OLKNK TgY mH *Te-998 9N0T zara @30 DtN0$ ze 33u10 Saye ©«@ 3441 Ond7D A3M awl oN O*TeeeT "LyT BVASNYEL Ga O3¥IG ONIN 4 ALITIBISIA B'gz2 Add andl otse non % Goldad 3AvH G8 90738 ONIM «20 M3HL¥3M G'7TeT Suva be/¥Ey Br Suva 86262 30N3¥3434 ONue Oy-vnd NOLLWLS @60 3SInuo oBKNIVE Ay 180 ---Page Break--- S8's6 Bey 9L"y aGt22 ostist 99rLz ar 40'o s2'eat co's So'y agtez

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15 2 4 2 castors ve. ee ae % FORAITHIFSRA 15 2 7 7 ‘ALAGOSTRAGAIS 29 ey 1s 3 FISH Lamar 8 2 2 e Fis Ecos ts 86 1e 165 ---Page Break--- 200 PLANKTON DE PuITa 4araTL a1 9c bloMAss 14 aLviee cute ABUNDANCE 1 4#/CUBIC METER statistics 3 ere er Be : siowass 2 2 1 13 ror er 364 asve 861 corerace 1008 ren asie st a ae 93 2a Lanvac > sc 2 43 Prenopons 7 “ ° 2 vemaciss 7 2 s ‘ GaDoceeals 1 5 2 teousas 2 ° s. 6 “rpvo~o7Es 2 1 ° 2 stevens @ e ° e maracta ° e ° ANVELID LamAE 15 a 20 4 crnREpese Lan 2 “ . 6 SoMIVO: Tt Lat s e « ScTDPROCT Lar 4 2 15 2 ‘SIVALVE LAQAE @ 4 s 2 sasrao=5 7S. 18 ta aa a PoRAMVEFSRA @ 2 5 e aLacostoacats 18 ° 2a . SISK Latuar 2 ° ° ° FISH Ecos 64 a2 a7 18 ---Page Break--- ZOOPLANKTON Mavart BIOWASS IN ML/ 189 CUBIC METERS ABUNDANCE IV NUMBERS/CUBIC METER Browass total corerons ouazToGvaTHS LarvacEANS -FTEROPODS-— ostracons LADOCERAYS wepusae SEPHONOPHORES crEvoPHoRES ‘TMALLACEA AIVELID LARVAE CURRIPEDE LAR ECHINODER! LAR ECTOPROCT LAR BIVALVE LARVAE GASTROPOD VEL FORAMINIFERA MIALACOSTRACANS FISH LARVAE FISH Ecos MEAL 18 1695 1209 st 24 20 48 23 aa VARIANCE 5 194650 12701 388 set a 258 10 ” 197 15 358 14 aan MAY 1/74 station 2 3 REPLICATES 195 Cele 12 To 24 ae To 2731 272 To 2187 270 e710 470 8 e a 870 e70 er e% 100 6s 36 86 ” ” mn an 16 12 70 18 9a ---Page Break--- zo0PLAITD1 Browacs Eh sie? ov ABUNDANCE IV NUMBERS/CHr Browass rota. copepons crastocraTa= LanvACEAYS PTEROPODS ostracons Lavocenais MEDUSAE stPHoVoPHonES CTEVOPHORES THALIACEA AUVELID LaRV, CURRIPEDE Lan ECHINODER! Lan SCTOPROCT LaR BIVALVE LARVAE GastroPop ve. FORAMINIFERA 1ALACOSTRACANS FISH LARVAE, aa 3s ene ems ens am 3 ens e 10 88 116 29 10 56 ina 1 69 ---Page Break--- DOPLALTOS PUITA iAnaTt 24 act Boiacs 1) wurise cvste aetens ABUNDANCE TY VUISENs/cUSIC “METER Had stones 3 en. ora. 1564 2ieas coPerons ten ise76 ae 29 sr 86 tat sam 4 3 ens osteacops 2 3 ems avocenass 1 3 ans MEDUSAE ° ° an stpnovoprones 1 x ems cTEvoPHORES ° e on THaLtacca ° ° ate AUVELID LARVAE 4 22 e710 16 CIRRIPEDE Lan a 22 eto 15 ECHINODER! Lan 5 12 #10 14 SCTOPROCT Lan

2 12 aru BIVALVE LARVAE 4 2 ems sastnoPoD ve. 14 38 eo 70 a2 FORAMINIFERA 2 19 etn MALACOSTRACANS ° 67 @ 70 29 FISH LARVAE e e a0 FISH Ecos se sis 26 10 135 201 ---Page Break--- ---Page Break--- APPENDIX 4.28 Copepod species at each station and for each sampling date. Explanatory notes for computer printouts- T. TURBINATA: ra turbinate T. STYLIFERA: stylifera SM CALANOIDS: Includes Paracalanus aculeatus Clausocalanus Faveaculus Mecynocera claudicans Kerocalanus sp. and other juvenile ‘calanoids ---Page Break--- 4.28 copepods abundance IN ‘/CUBIC METER STATION 1 station 2 C2 > © 3 Tows T. TURBINATA 137 675 T. STYLIFERA 3 8 St calanoids 197 208 calanoids ' 5 ACARTIA ° 6 nauplii 1 s FARRAULA, 1s n conycneus 38 46. cETHOWA 104 8 oucaca 18 19 204 station a ©2 Tows) ais ° 279 n 1 15 or 136 MAY 14/74 OFFSHORE © 2 TONS) 198 ---Page Break--- copepods ABUNDANCE IN ‘T. TURBINATA T. STYLIFERA St calanoids ewvoca.avys calanoids ACARTIA Wiprswa UCHAETA EUCAL ANUS FARRAULA conycneus cETHOWA oucaca eycuate 4ETER station 1 C1 tow 20 13 692 5 2 45 19 16 6 130 ae sectart station 2 © 3 Tows) a 2 260 2 10 58 16 station 3 C1 tow s7 18 18 August 774 OFFSHORE ©1Tows> 323 13 3e 13 33 ---Page Break--- copepods savatt 31 OCTOBER /74 ABUNDANCE IN #/CUBIC METER STATION 1 STATION 2 STATION 9.——OFFSHORE Citow> 3 tows) Ctr © Ca TOW T. TURBINATA 173 225 sia st T. STYLIFERA 2 ae 5 e St CALANOIDS 589 766 290 32a Nauplii 2 3 ° 6 camorta 6 e 20 2 acantta ° 13 2 a Lucicutra 13 3 e ° BuCALAUS 9 2 e ‘ FARRAULA 1s 24 a9 2s conrcatus 29 38 a 37 ormiowa 17 169 186 te oucaca ee 16 29 26 ---Page Break--- copepods Mavatt May taza sowrDAIcE 1 wUNSERS/cUBIC METER ‘Shepuicares next vantaice 498 cate T. TURBINATA ors serees © 70 1562 nermirena . ‘ or 13 st calanoids 208 130 137 70 an calanoids s 2 ime scantta 6s 7287 210 278 urercuta 5 2 ime Fansatua " 18 Lm a conycneus as 198 8 t0 198 ormiowa ee 787 14 1 ise eveara 182 om se 207 ---Page Break--- copepods mavatt ABUNDANCE IY NUMBERS/CUBIC METER seav ‘T. TURBINATA a7 T. STYLIFERA 2 9 CALANOIDS 260

NawOCALAIUS 3 caLnnorta 2 ACARTIA ae worwua 2 puciaeta ° Buca aus ° FARRAVLA ey convcazus te ormiowa 36 Oncaea 16 VARIANCE 12 2 1573 23 34 18 135 ta 15 august 774 statio’ 2 ‘2 REPLICATES 198 cote 28 10 as ems 161 10 358 em? ems 14 70 43 em 20 29 70 86 6 10 25 ---Page Break--- coPePons MavaTE 31 ocTaSE7 774 statioy 2 ABUIDAICE IN NUVBERS/CUBIC METER 3 REPLICATES aeay VARIANCE +95 Gere T.TuRBL¥ata 225 2907 92 70 959 T.STYLIFERA 12 36 8 10 27 St caLAvorDs 766 sea9 532 1 999 NawocaLavus 3 9 emu CaLAvoPrA . ° ene ACARTIA 13 133 © 10 a2 Lucrcuria 3 ° et BUCALAVUS 2 3 em. FARRAYULA 2a 38 9 10 40 conycasus 38 3 29 7 46 ortHowa 169 1299 19 10 296 oucaza 18 108 @ 10 4a ---Page Break--- APPENDIX 4.94% Benthic Stations at Punta Manati STATION 4 east of Manati River (Pt, Manati) 2 January 1973 Depth: 7-208 Investigator: S. Martin STATION 2 Location: Pe. Manati (East of Manat! River) Date: 6 June 197%, 1% August 197% Depth: ae Investigator: P.M, Yoshioka STATION 3 Location: Pt, Manati (East of Manati River) Date: 6 June 197% Depth: ae Investigator: P.M. Yoshioka ‘TRANSECT A east of Manati River, parallel to shore 24 May 1975 15-209 P.M, Yoshioka ‘TRANSECT 8 Location: Pe, Manati (Bast of Manat River) 31" May. 1973 jo-179 Investigator: V. Vicente TRANSECT C Location: offshore of Manati River moxth Date: 29 Mar, 1378 Deptt 20m Investigator: P.M, Yoshioka TRANSECT D Location: wost of Manati River (Palmas Altas) Date: 11 May 1973 Deptt 0-179 Investigator: V, Vicente ‘Refer to Figure ¥.3-Fi. 210 ---Page Break--- APPENDIX. 4.34 (continued) STATION & Location: Date: Dep: Investigator: STATION 5 Location: Date: Depth: Investigator: a Tecation Date Investigator: an Inshore of Seation 2 AW August 197 ae P.M, Yoshioka, west of Manati River (1/2 mile W) 31 January. 1973 7 = 20. (15 m) 8. vartin Rocky area east of the Manati River mouth 30 January 1973, 14 June 1973, 21 February 197%, 9 Apria 1978 D, Martin ---Page Break--- APPENDIX 4.38 Macro invertebrates and fish observed ‘at Punta Manat!. STATION STATION 2 3 ‘ANIMAL, KINGDOM Phylum

Porifera Anthosigmella varians ‘Caligepengla vaginas ‘Sunshine caverns Trefna strobitina jularfa magca ‘Sphaeroclonspongia vesparia ae: Phylum Cnidaria (Class Hydrozoa ites so * x Subclass Zoantharia saricia 9p ifocetala stoke Biploria sp. Phylum Chordata ‘Subphylum Vertebrata ‘Class Pisces Family Holocentridae Holocentrus, sp. x x Family Serranidae Cophatopholia fulva x x Family Carangidae Caranx crysos x 212 ---Page Break--- APPENDIX 4.38 (continued) Station Chordata (continued) Family Botjenidae Coyunus chrysunas x Family Serranidae Eyuetue sp. x Family Lutidae Pseudupeneus maculatus x Family Chondrichthyes Setseantias Snlestar x Family Pomacentridae Fonacentrus partitus x x Family Labridae Sotianss ruts x Asses Bifosctatum x x Family Acanthuridae Acanthurus sp. x x Family Scaridae Scarberonorus sp. x 213 ---Page Break--- Sepyuoteg ‘seprep Tudo seppo059 7409 seprmawerado ‘seproosouseuny TaeUOTeS BOPRIOG epsuseang ‘suoyawis uostod esoysavou 3e paroet {os seszede ueTA 96H KIGNIGEY ---Page Break--- Adyae BRAOUOTT IST saroas epyBunaey upqtolody ouprunsaes oepraaeututs sepraauscoro seprupaosy ---Page Break--- Aepave woporset Ss oeprrTeH ‘sepruseyos: g sep Keepruog orppaseo ---Page Break--- ---Page Break--- Sepranqauroy ---Page Break--- APPENDIX 43D Infaunal and epifaunal species in 1/4 n? eanpl STATION 4 Phylum Annelida CLASS Polychaeta Family Aphroiditidae Eunice rubra Sabeliidae (family) 2 Sytlidae (Family) Unid, polychaet © 1 Sylile’ prolifera Phylum Sipunculida Sipuncuria ep. #2 2 StBnSuLIa op. #7 5 Tae stpmneniota Phylum Mollusca CLASS Gastropoda Vermicultura knorné STS ct ‘Syaathan poser ‘Hissstie maT Ticostata Trivia ate CLASS Pelecypoda Anadare notabilis rea imbricata — ‘Diplodonta qucteifornis Faeete ease teeta , 219 3 8 Station 1 ---Page Break--- APPENDIX 4.30 (continued) STATION Phylum Arthropoda CLASS Crustacea SUBCLASS Malacostraca, Order Tanaidacea Alctrona hineuta ‘Cirelana obtrunest order Amphipoda Unid. gamaria 2 order Decapoda Suborder Natantia Section Caridea Unid. caridea 1

Synaipheus minvs Suborder Reptantia Section Srachyura Zplattus ditavatus 1 ‘Fortune sp- 1 Section Anomura Pachycheles ackleianus Phylum Bryozoa Unia. Bryozoa ath at Phylum Echinodermata CLASS Echinoidea Bucidaris tribuloides 2 4 Welifta sextesperforata CLASS Asteroidea Asterina folius 1 CLASS Ophiuroidae ‘Amphuridae (family) 2 Ophiactis milter Ophiactis echinata Slots eary 1 Ophionerefe aquasulcos 220 STATION 1 ---Page Break--- APPENDIX 4.90 (continued) station startow 3 1 A 8 Phylum Chordata Subphylum Urochordata CLASS Ascidea Unia. ascidian x * 2 species ** 3 unid. bryozoan: 3 different species 221 ---Page Break--- APPENDIX 4.4A Common plant species List for the Punta Manati area, Grasses, Vines, Herbs: ‘Bidens pilosa Burgeeria siarab Chrysobatanus ep. Cocone weitere Cocos nucifera Crotonatin retusa Doda narteina Echinochloa fructicosa Ipanema pea-caprae, Jones sp. Yyltega peruviana Eantana favolucrata Plumeria alba Psychotria undata Rand =p. Rawoleia totraphylie Reniera naritina Scaevola plumeria! Sideroxylon foetidum nun Snttax ep. Sporobolus virginicus Tabebuia patriciae Hania latifoliolara 228 ---Page Break--- APPENDIX 4.4B Terrestrial species List at Punta Manati, SPECIES Leptodactylus sp. Anolis cristatellus Aves: Columbigallina passerina Minus polygottus Togus nexteanus 28 ---Page Break--- Notices This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of the employers nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed or represented that it must not infringe privately owned rights ---Page Break---