

## CORAL TRANSPLANTING: A TECHNIQUE FOR REPOPULATING

### DEVASTATED REEF AREAS

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This report outlines a method used to transplant both hard and soft corals into an area of Molasses Reef in the Key Largo National Marine Sanctuary that was damaged by the August 4, 1984 grounding of the freighter WELLWOOD (Fig. 1). Grounding of the WELLWOOD killed an estimated 90 percent of all hard and soft corals within a 644 m<sup>2</sup> area of the impact zone. An additional 638 m<sup>2</sup> area of live coral is estimated to have sustained 75 percent mortality either by direct contact with the ship's hull, contact with and/or burial under grounding-generated rock debris, or by shading and smothering during the 12 days the ship remained hard aground (Hudson and Diaz, in prep). Still easily identified in aerial photographs taken almost 1 year after the incident, the main damage areas (Fig. 2) remain a virtual roadbed of pulverized coral debris that is gradually being coated with a succession of algal epiphytes (Fig. 3).

Smith (1985) monitored recolonization of hard and soft corals over a 5-year period at a ship grounding site on a Bermuda reef. He found that, although there was active recruitment of hard corals into the damaged area, an average of only 25 cm<sup>2</sup>/m<sup>2</sup> per year of coral cover has been generated there by natural means. Surprisingly, he reported that new octocorals (soft corals) have not appeared on the damaged reef despite the fact that they are normally abundant on Bermudan reefs. Dr. Thomas Bright and his associates are presently conducting a study similar to Smith's at the WELLWOOD site. Thus far, they report little evidence of new coral growth in the impact area. As of this writing, this author has observed no new hard corals in the reef framework damage area and little evidence of recolonizing by soft corals. Consequently, in order to test a possible alternative to slow, random recruitment and growth of isolated corals over long time periods, a 16 m<sup>2</sup>

test plot of transplanted hard and soft corals was established along one edge of the major impact area (Fig. 2).

## METHODS

### Site Selection

The 16 m<sup>2</sup> area test plot selected for transplanting contained no living hard or soft corals and had sustained only moderate (1 m<sup>2</sup>) reef framework damage. Preparation of substrate prior to transplanting was effected by placing a 16 m<sup>2</sup> frame over the plot and removing all rock debris together with attached dead soft coral skeletons. Coral rubble was placed with other grounding-associated debris in a nearby natural depression. In situ soft coral skeletons were removed with hammer and chisel and stored for future reference. Attached dead hard corals were left in place. Although numerous holes, fissures, and other natural voids were present within the plot, it was necessary to drill additional ones in the rock surface so that each specimen could be securely cemented into the reef framework. Fifteen holes 4" (10 cm) in diameter and 4" (10 cm) deep were drilled at random on suitable rock surfaces within the plot. A similar series of 25 smaller holes 2½" (6.5 cm) in diameter by 3" (7.5 cm) deep were also drilled to complete preparation of the transplant plot.

### Collecting and Transporting Specimens

Using information on species composition and density provided by Thomas Bright of Texas A & M University and Jennifer Lowry of the Florida Department of Natural Resources, a collection of representative hard and soft corals (Table 1) was made at nearby Pickles Reef (Fig. 1). Selected corals were transported by boat to the transplant site in open 30-gallon plastic containers filled with fresh seawater. At the site, divers hand-carried individual specimens from the boat down to the plot.

A decision to limit initial soft coral transplant specimens to 30 was made based on the author's previous experience that most alcyonarians are difficult

to relocate without incurring injury to delicate holdfast tissue that often leads to eventual death of the transplant. It was deemed prudent to relocate a moderate number of specimens and adopt a wait-and-see attitude before committing additional time and corals to the plot.

Fortunately, hard corals did not pose this problem, due mainly to protection of their tissue by a stony skeleton and relatively low number (11) needed to approximate pre-grounding density levels.

Both hard and soft corals were secured to the substrate with a quick-setting underwater cement composed of 2 parts molding plaster and 8 parts Type II Portland grey cement (Figs. 4A-D). Mixed to a putty-like consistency with water, the material remains in a plastic state for approximately 5 minutes before hardening. Specimens were anchored to the seabed by forcing the attachment base of each coral into a soft ball of cement that had been wedged into a natural or drilled hole in the reef framework. Lead weights were sometimes used to hold specimens in place until the cement had completely hardened.

Time expended to establish this experimental plot amounted to 5 days. Of this time,  $1\frac{1}{2}$  days were spent preparing the site, and the remaining  $3\frac{1}{2}$  days used to collect corals, cement them in place, and identify all transplanted specimens (Appendix). Based upon 77 in situ soft coral skeletons removed from inside the transplant plot, it will be necessary to add an additional 45 alcyonarians at a later date to approximate their abundance prior to grounding of the WELLWOOD. Health of the transplants will be monitored quarterly for 1 year and more often if conditions warrant doing so. At this writing, all hard and soft corals appear to be in excellent health. Both corals and cement passed their first "survival" test, as heavy ocean swells generated by fringe winds from Tropical Storm Bob buffeted Molasses Reef during the week of July 22, 1985 (Fig. 5).

Attached and included as a part of this report is a day-by-day accounting of time expended to establish the transplant site. This and other data will be

used to assist NOAA in establishing cost estimates for possible future restoration of the grounding site.

#### ACKNOWLEDGMENTS

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## REFERENCES

- Hudson, J.H., and Diaz, Renato, A survey of reef framework damage at the WELLWOOD grounding site: Molasses Reef, Key Largo National Marine Sanctuary, Florida: Report to NOAA Marine Sanctuaries Division, U.S. Department of Commerce.
- Smith, S.R., 1985, Reef damage and recovery after ship groundings on Bermuda (abs.): International Coral Reef Congress, 5th, Proceedings, v. 2, Tahiti, p. 354.

## FIGURE CAPTIONS

Figure 1. Map of study area.

Figure 2. Aerial photograph of WELLWOOD grounding site.

Figure 3. View looking east across largest impact area.

Figure 4A-C. Diver transplanting hard and soft corals in  $16\text{ m}^2$  test plot.

Figure 4D. Closeup of healthy soft coral holdfast from Figure 4C.

Figure 5. Transplanted and adjacent untransplanted  $16\text{ m}^2$  plots at the grounding site. See Figure 2 for location of transplant site.

## APPENDIX

## CORAL TRANSPLANTING AT MOLASSES REEF

(Day 1)

| <u>Date</u> | <u>Time</u> | <u>Operation</u>                                                                                                                                                                                        | <u>Elapsed<br/>Minutes</u>       |
|-------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 7-16-85     | 9:05a       | Move boat, divers and equipment from John Pennekamp State Park marina to WELLWOOD impact site on Molasses Reef. . . . .                                                                                 | 25                               |
|             | 9:30a       | Anchor boat and search for suitable transplant site                                                                                                                                                     |                                  |
|             | 10:50a      | Locate site and reposition boat at this location. . . . .                                                                                                                                               | 80                               |
|             | 10:50a      | Reset transect lines and position transect plot accurately with measuring tapes . . . . .                                                                                                               | 40                               |
|             | 11:30a      | Assemble 4 m <sup>2</sup> search frame and place over transplant site. Remove rubble from site and transfer to nearby depression. Clear out dead in-situ soft coral skeletons from inside plot. . . . . | 170                              |
|             | 2:20p       | Drill four 4" by 4" deep holes in plot at 10 minutes per hole. Drill five 2½" by 3" deep holes at 6 minutes per hole. Stop work. . . . .                                                                | 70                               |
|             | 3:30p       | Return to Pennekamp marina                                                                                                                                                                              |                                  |
|             | 4:00p       | Arrive Pennekamp marina . . . . .                                                                                                                                                                       | 30                               |
|             |             | Clean up dive gear, secure boat                                                                                                                                                                         |                                  |
|             | 5:15p       | End day . . . . .                                                                                                                                                                                       | 75                               |
|             |             |                                                                                                                                                                                                         | 490 min<br>= 8 hrs and<br>10 min |

(Day 2)

| <u>Date</u> | <u>Time</u> | <u>Operation</u>                                                                                                                                                                            | <u>Elapsed<br/>Minutes</u>      |
|-------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 7-17-85     | 9:20a       | Depart John Pennekamp marina                                                                                                                                                                |                                 |
|             | 9:45a       | Arrive Molasses reef. . . . .                                                                                                                                                               | 25                              |
|             | 9:45a       | Anchor up on transplant plot and continue site preparation. Drill 11 additional 4" diameter by 4" deep holes, and 20 more 2½" by 3" deep anchor holes for securing transplants to substrate |                                 |
|             | 1:35p       | Complete drilling of holes. . . . .                                                                                                                                                         | 230                             |
|             | 1:35p       | Depart Molasses Reef for coral collecting site at Pickles Reef                                                                                                                              |                                 |
|             | 1:40p       | Arrive Pickles Reef. . . . .                                                                                                                                                                | 5                               |
|             | 1:40p       | Anchor boat and begin collecting soft corals. Collected three hard corals and six soft corals                                                                                               |                                 |
|             | 3:40p       | Complete collecting. Return to Molasses Reef. . . . .                                                                                                                                       | 120                             |
|             | 3:50p       | Arrive at Molasses Reef. . . . .                                                                                                                                                            | 10                              |
|             | 3:50p       | Transfer corals from boat to site and begin cementing specimens into plot                                                                                                                   |                                 |
|             | 5:50p       | All specimens cemented in place. . . . .                                                                                                                                                    | 120                             |
|             | 6:10p       | Left site. (Assisted stranded boater) . . . . .                                                                                                                                             | (20)                            |
|             | 6:40p       | Arrive Pennekamp marina. . . . .                                                                                                                                                            | 30                              |
|             |             | Clean up gear, secure boat                                                                                                                                                                  |                                 |
|             | 7:30p       | End day. . . . .                                                                                                                                                                            | 50                              |
|             |             |                                                                                                                                                                                             | 610-20=590<br>min = 9 hrs 50 mi |

## CORAL TRANSPLANTING AT MOLASSES REEF

(Day 3)

| <u>Date</u> | <u>Time</u> | <u>Operation</u>                                                                               | <u>Elapsed<br/>Minutes</u> |
|-------------|-------------|------------------------------------------------------------------------------------------------|----------------------------|
| 7-18-85     | 11:25a      | Depart John Pennekamp marina                                                                   |                            |
|             | 11:55a      | Arrive Pickles Reef. . . . .                                                                   | 30                         |
|             | 11:55a      | Begin collecting corals for transplant site. Collected<br>three hard corals and 12 soft corals |                            |
|             | 1:55p       | Complete collecting. . . . .                                                                   | 120                        |
|             | 1:55p       | Depart Pickles Reef                                                                            |                            |
|             | 2:10p       | Arrive Molasses Reef transplant site . . . . .                                                 | 15                         |
|             | 2:10p       | Anchor up boat and transfer all specimens to bottom.<br>Begin cementing corals in place        |                            |
|             | 5:30p       | Completed transplanting 15 specimens into plot . . . . .                                       | 200                        |
|             | 5:30p       | Depart Molasses Reef                                                                           |                            |
|             | 6:00p       | Arrive Pennekamp marina. . . . .                                                               | 30                         |
|             | 7:15p       | Complete gear and boat clean-up.                                                               |                            |
|             | 7:15p       | End day. . . . .                                                                               | 75                         |
|             |             |                                                                                                | 470 min =<br>7 hrs 50 min  |

(Day 4)

| <u>Date</u> | <u>Time</u> | <u>Operation</u>                                                                                                         | <u>Elapsed<br/>Minutes</u>                            |
|-------------|-------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| 7-19-85     | 9:15a       | Depart John Pennekamp marina                                                                                             |                                                       |
|             | 9:45a       | Arrive Pickles Reef. . . . .                                                                                             | 30                                                    |
|             | 9:45a       | Anchor boat and begin collecting corals for transplant<br>site                                                           |                                                       |
|             | 11:55a      | Complete collection of five hard corals and 12 soft corals                                                               | 130                                                   |
|             | 11:55a      | Depart Pickles Reef                                                                                                      |                                                       |
|             | 12:10p      | Arrive Molasses Reef site. . . . .                                                                                       | 15                                                    |
|             | 12:10p      | Anchor boat and deposit all corals on bottom. Begin<br>cementing in 17 remaining specimens                               |                                                       |
|             | 4:30p       | Complete transplanting . . . . .<br>(NOTE: 1 hour delay due to thunderstorms. Actual trans-<br>plant time = 200 minutes) | 260                                                   |
|             | 4:30p       | Depart Molasses Reef                                                                                                     |                                                       |
|             | 5:10p       | Arrive Pennekamp marina. . . . .                                                                                         | 40                                                    |
|             | 6:30p       | Clean up gear, haul boat from water for return to Miami.                                                                 |                                                       |
|             |             | End field work day . . . . .                                                                                             | 80                                                    |
|             |             |                                                                                                                          | 555 min =<br>9 hrs 15 min<br>- 1 hr =<br>8 hrs 15 min |

## CORAL TRANSPLANTING AT MOLASSES REEF

(Day 5)

| <u>Date</u> | <u>Time</u> | <u>Operation</u>                                                                                                                                                                                                                                                        | <u>Elapsed<br/>Minutes</u> |
|-------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 8-4-85      | 9:00a       | Depart John Pennekamp marina                                                                                                                                                                                                                                            |                            |
|             | 9:35a       | Arrive transplant site, Molasses Reef. . . . .                                                                                                                                                                                                                          | 35                         |
|             | 9:35a       | Anchor boat, field identification of transplanted hard<br>and soft corals and collection of voucher specimens for<br>laboratory analysis. Samples of specimens not in plot<br>also collected for future field use. Video footage of<br>transplant site taken this date. |                            |
|             | 4:30p       | Depart Molasses Reef . . . . .                                                                                                                                                                                                                                          | 415                        |
|             | 4:50p       | Arrive John Pennekamp marina . . . . .                                                                                                                                                                                                                                  | 20                         |
|             | 5:55p       | Clean up boat, secure gear, end work day . . . . .                                                                                                                                                                                                                      | 65                         |
|             |             |                                                                                                                                                                                                                                                                         | 535 min =                  |
|             |             |                                                                                                                                                                                                                                                                         | 8 hrs 55 min               |

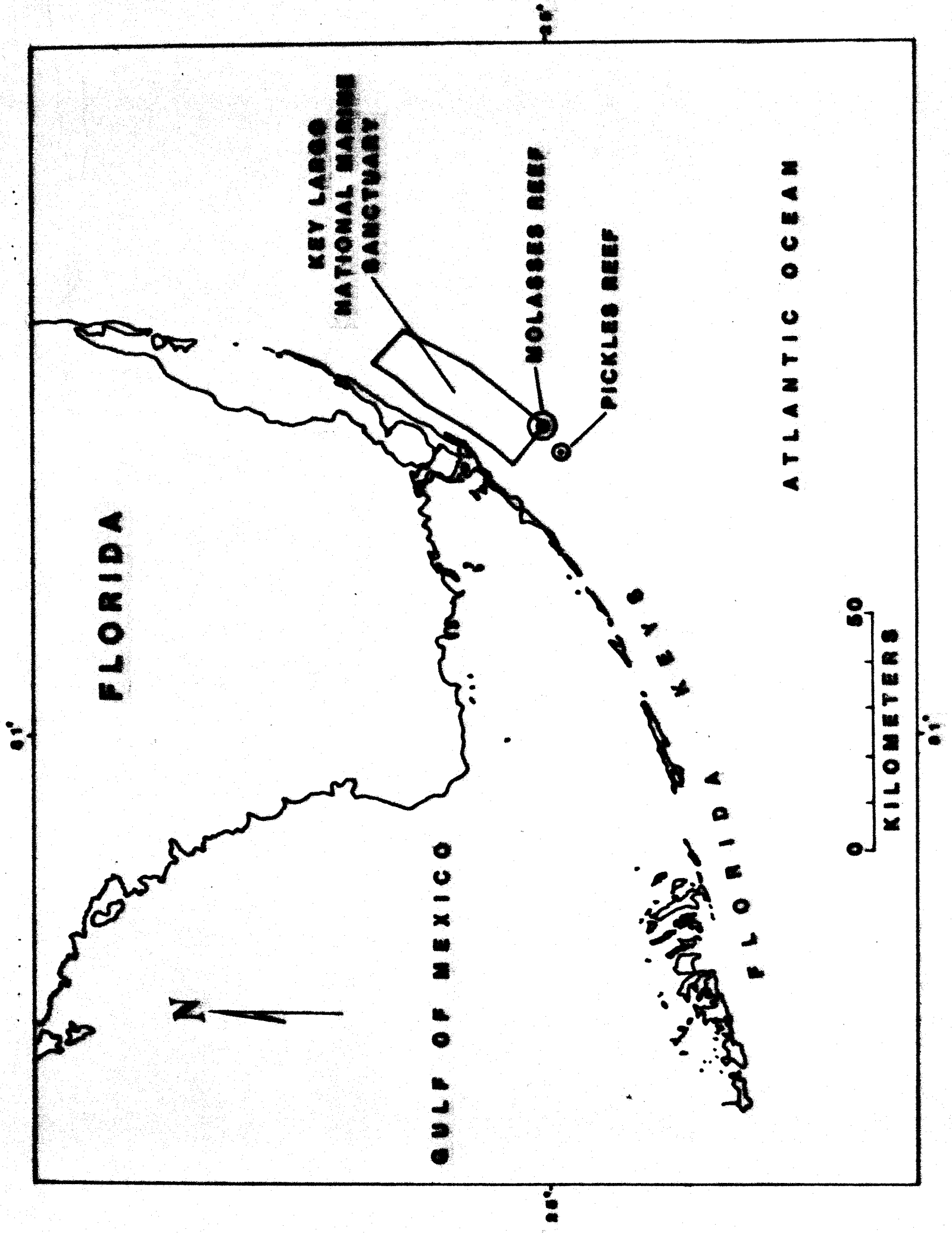
Table 1. - Species Composition and Number: 4 m<sup>2</sup> Transplant Plot

HARD CORALS

| <u>Species</u>                   | <u>Number</u>   |
|----------------------------------|-----------------|
| <i>Dichocoenia stokesii</i>      | 3               |
| <i>Agaricia agaricites</i>       | 2               |
| <i>Diploria strigosa</i>         | 1               |
| <i>Diploria labyrinthiformis</i> | 1               |
| <i>Montastraea annularis</i>     | 1               |
| <i>Montastraea cavernosa</i>     | 1               |
| <i>Meandrina meandrites</i>      | 1               |
| <i>Siderastrea siderea</i>       | 1               |
|                                  | <u>11 total</u> |

SOFT CORALS

| <u>Species</u>                     | <u>Number</u>   |
|------------------------------------|-----------------|
| <i>Pseudopterogorgia americana</i> | 14              |
| <i>Gorgonia ventalina</i>          | 4               |
| <i>Plexaura flexuosa</i>           | 2               |
| <i>Eunicea mammosa</i>             | 2               |
| <i>Eunicea tourneforti</i>         | 1               |
| <i>Eunicea calyculata</i>          | 1               |
| <i>Eunicea fusca</i>               | 1               |
| <i>Plexaurella fusifera</i>        | 1               |
| <i>Plexaurella grisea</i>          | 1               |
| <i>Muriceopsis flavida</i>         | 1               |
| <i>Pseudopterogorgia acerosa</i>   | 1               |
| <i>Muricea atlantica</i>           | 1               |
|                                    | <u>30 total</u> |



FLORIDA

KEY LARGO  
NATIONAL MARINE  
SANCTUARY

MOLASSES REEF

PICKLES REEF

ATLANTIC OCEAN

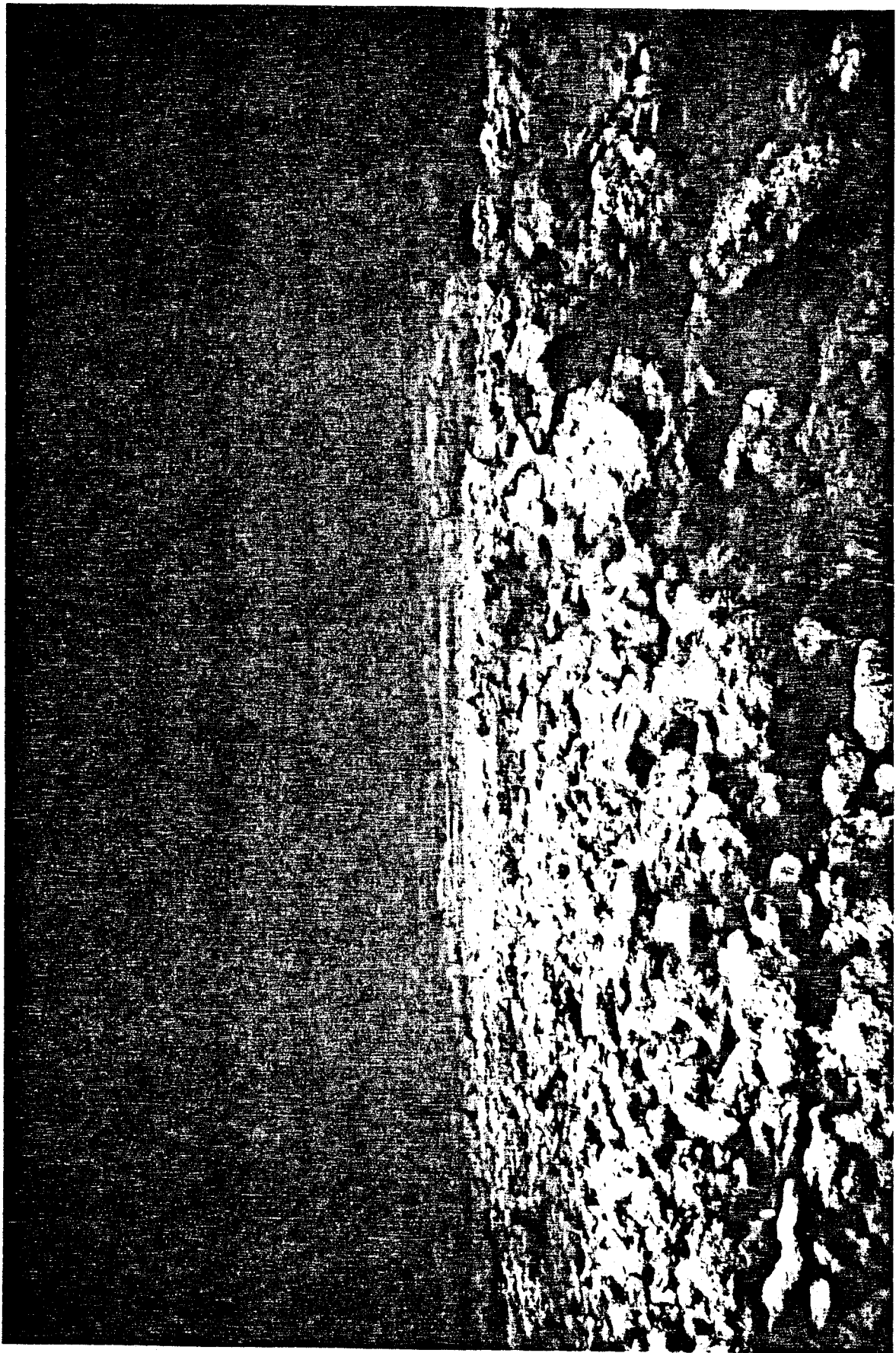
GULF OF MEXICO

FLORIDA

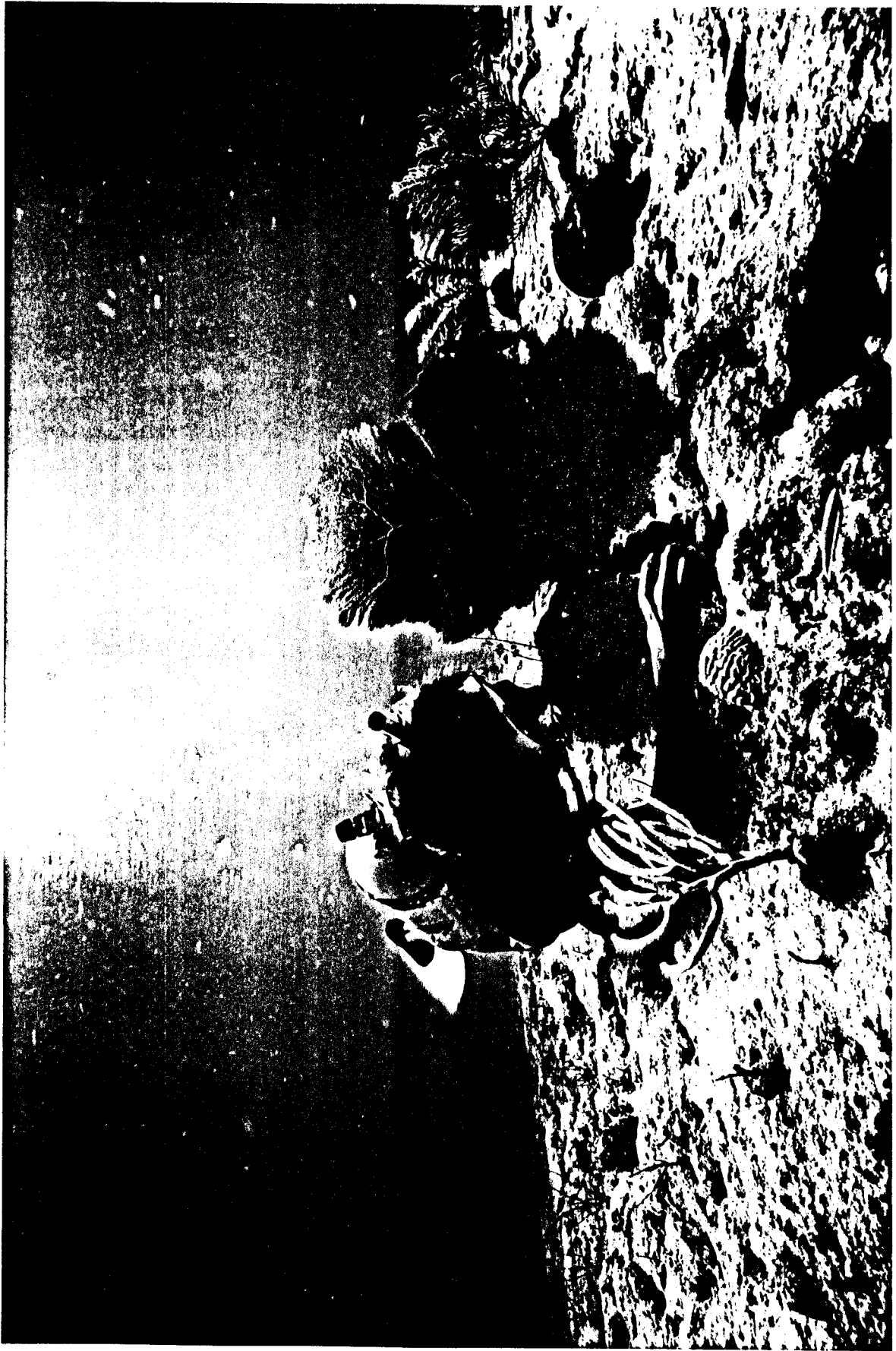
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KILOMETERS



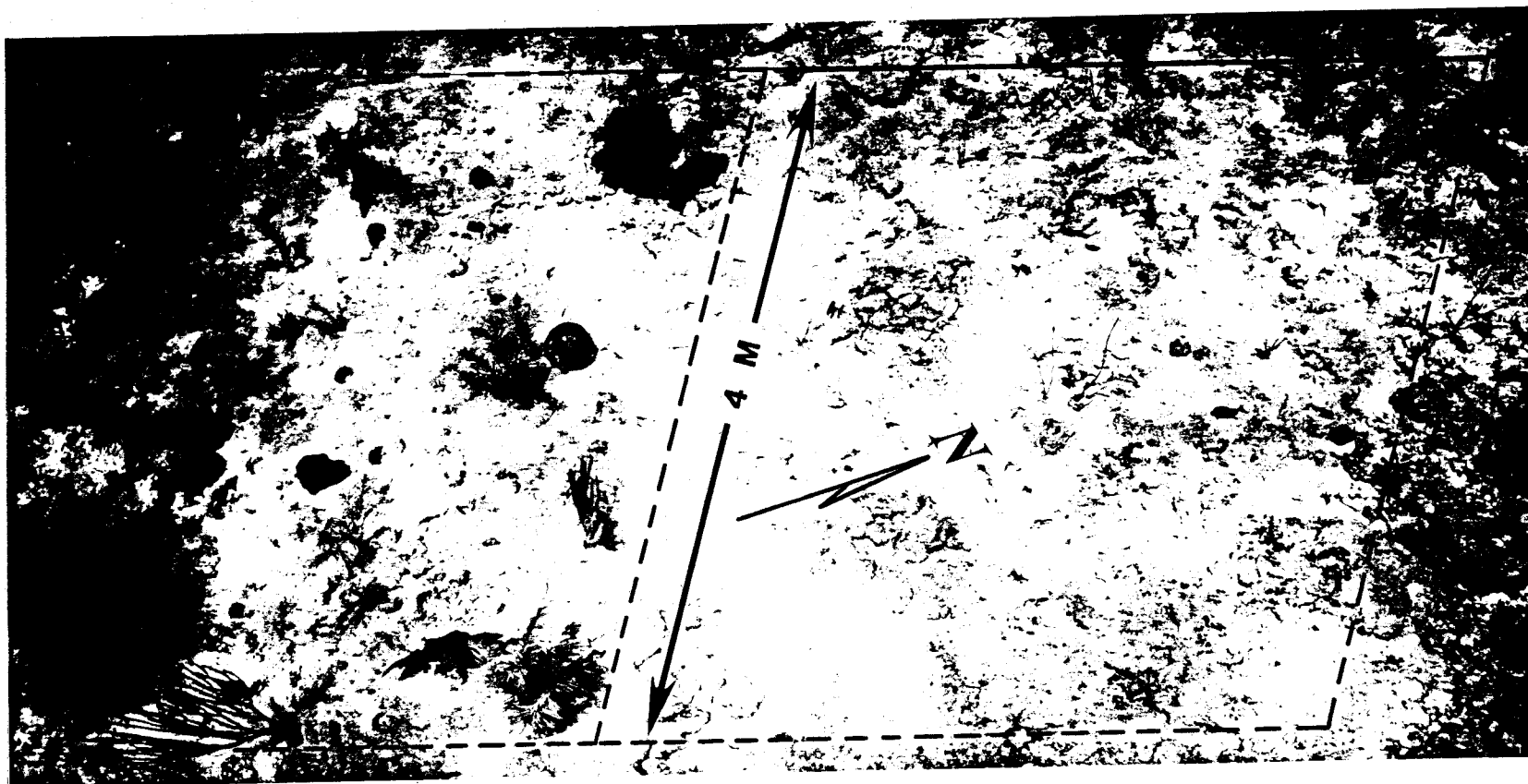
- =NOAA "NO ANCHORING ZONE" BUOYS      ○=UNDERWATER TARGETS  
■=CEMENT GROUTING PLOT











**TRANSPLANTED**

**NOT TRANSPLANTED**