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FLORIDA MARINE RESEARCH PUBLICATIONS

Ecology, Resource Rehabilitation, and Fungal Parasitology of Commercial Oysters, *Crassostrea virginica* (Gmelin), in Pensacola Estuary, Florida

EDWARD J. LITTLE AND J. A. QUICK, JR.

Florida Department of Natural Resources

Marine Research Laboratory

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ERRATA

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Number 21

Page 8, paragraph 2, line 8 should read "more saline water of Santa Rosa Sound (Menzel,"

Page 8, paragraph 3, line 4 should read "Bay, southern Escambia, Blackwater Bay, and"

Page 8, paragraph 3, lines 6 and 7 should read "the respective areas where rehabilitation was found to be either impractical (northern Escambia Bay,"

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Editor

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100 Eighth Avenue SE St. Petersburg, Florida 33701

ABSTRACT

Little, E.J. and J.A. Quick, Jr. 1976.Ecology, Resource Rehabilitation, and Fungal Parasitology of Commercial Oysters, *Crassostrea viginica* (Gmelin) in Pensacola Estuary, Florida. Fla. Mar. Res. Publ. 21. 89 pp. Between April 1972 and July 1973, 452 moundlike artificial oyster reefs constructed with 26,000 m^3 of *Rangia cuneata* clam shell and/or oyster mudshell were placed on approximately 8.5 hectares (23 acres) at two sites in East Bay and three sites in Escambia Bay to help replenish oyster stocks depleted by poor recent annual recruitment and by a severe epizootic of parasitic fungus *Labyrinthomyxa marina*, in September 1971. Rehabilitation was preceded by a hydrographic and bathymetric survey characterizing local oyster ecology and identifying bottoms suitable for reef construction. Most bottoms were silty mud, too soft to support artificial reefs, but limited suitably firm areas were located where wide, sandy shallows merged with deeper, muddy basins. Site ecological conditions were generally favorable, but adverse conditions (e.g., freshwater flooding, excessive salinity) may occasionally occur. Some Escambia Bay sites were stocked with oysters dredged from natural reefs closed to harvesting, providing oystermen with a resource until artificial reefs became productive. Oyster predators and fouling organisms were generally too scarce to threaten rehabilitation. Successful recruitment (spatfall) was negligible in 1970, increased substantially by autumn 1974, and occurred primarily in late summer and/or autumn. Recruitment intensity decreased markedly with increasing proximity to eutrophic northern Escambia Bay. Seed oysters, initially scarce on artificial reefs, became more abundant because of good spatfalls in autumn 1973 and 1974. Growth averaged 20-25 mm per year. Information on fungal parasitology, oyster spawing incidence, and condition of meats is also presented.

Contribution No. 280, Florida Department of Natural Resources Marine Research Laboratory

This public document was promulgated at an annual cost of $4250 or $1.93 per copy to provide the scientific data necessary to preserve, manage, and protect Florida's marine resources and to increase public awareness of the detailed information needed to wisely govern our marine environment.

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FIGURES

INTRODUCTION

During the first week of September 1971, over 90% of the commercially harvestable oysters, *Crassostrea virginica* (Gmelin), in northwest Florida's Escambia Bay were found dead. This mortality resulted from "dermo disease" caused by the fungus *Labyrinthomyxa marina* (Mackin, Owen, and Collier) Mackin and Ray, 1966, and was promoted by degraded water quality (Quick, 1971; Young, 1971). A loss of $307,000 in oyster harvests was projected over the next three years.

Rehabilitation of this devastated resource was initiated by the Florida Department of Natural Resources. From September 1971 through February 1972, a reconnaissance survey was conducted to determine best means and locations to accomplish this. Causes of the September epizootic and probability of its recurrence were determined; estuarine hydrography was characterized, bottom composition and topography were studied, and aspects of oyster ecology, such as growth, mortality, recruitment, and predation were elucidated.

Upon completion of the reconnaissance survey in March 1972, rehabilitation programs funded by a $200,000 National Marine Fisheries Service grant (2-167-D) began and these continued through June 1973. Rehabilitation sites were delimited and hard substrate "cultch", such as oyster and clam shell, was placed on the bay bottom to form artificial oyster reefs. Rehabilitation sites were also stocked with oysters from other areas. Sites were periodically sampled to ascertain recruitment of young oysters ("spatfall") and condition of cultch. The methods used in this program were similar to those proven successful by St. Amant (1958), May (1972), Pollard (1973), Tarver and Dugas (1973), and Whitfield (1973) in other oyster reef rehabilitation programs along the Gulf coast. Results of both the reconnaissance survey and the rehabilitation programs are summarized in this paper.

STUDY AREA DESCRIPTION

The Pensacola Bay estuary (Figure 1) is comprised of Pensacola Bay, East Bay, Escambia Bay, and associated tributaries. Principal environmental characteristics have been outlined by the Florida Coastal Coordinating Council (1971). With the exception of metropolitan Pensacola, most surrounding land area is undeveloped woodlands.

Climate is temperate and rainfall usually occurs throughout the year (Table 1) but is heaviest and most frequent in summer (U. S. Department of Commerce, 1972). Although winds are strongest in March, bay waters are rendered very choppy by "northers" (continental polar air masses) which blow for days in winter, as well as by gusty "southwesters" (tradewind reinforced sea breezes) which develop on most summer afternoons. Each seasonally influence water levels, circulation, and surface conditions of Gulf estuaries (Gunter, 1967). Tides are diurnal and of narrow range, varying from 1 m at the bay mouth to 0.3 m in upper bays.

Like most other Gulf estuaries, Escambia and East Bays were formed during the past 11,000 years as rising sea levels submerged surface drainage basins (Gunter, 1969). Bay bottoms are now floored chiefly by fine fluvial clays (Horvath, 1968) which cover many extinct or "fossil" oyster reefs (Radcliff Materials Corporation, 1967). Several fossil shell deposits are exposed and support viable oysters although most lie under 1-2 m of mud.

Along most bay shorelines, a shallow unvegetated subtidal sand flat extends outward for 100-300 m. At 1.5-2.0 m depth, this shelf drops abruptly to 2.5-3.0 m (National Ocean Survey (NOS) Chart 1265).

There is occasional freshwater flooding in Escambia and East Bays (Brice, 1898; Prytherch, 1933). The major source in Escambia Bay is the Escambia River, with a mean discharge of 167 m^3/sec (5899 cfs) and a range of 16-2190 m^3/sec (578-77,200 cfs), depending upon precipitation (measurements made $\simeq$ 64 km upstream at the Century, Florida, gauging station; U. S. Department of Interior, 1970). Escambia River flows during the study period are compared with historical averages in Figure 2. East Bay receives water in smaller amounts from the Blackwater, Yellow, and East Bay Rivers.

Degraded water quality in Escambia Bay has been abundantly documented by Florida State Board of Health (1969a), Hopkins (1969), Federal Water Pollution Control Administration (FWPCA) (1970), Environmental Protection Agency (EPA) (1971a, 1971b), Gallagher (1971) and others. Poor circulation in northern Escambia Bay allows wastes from paper and chemical industries and from domestic sources to accumulate in both the Escambia River system and northern Escambia Bay, with resultant eutrophication (EPA, 1971a).

Much of the bottom of Escambia Bay is covered with flocculent organic anaerobic muds a few centimeters to over 2 m thick (EPA, 1971a). Large

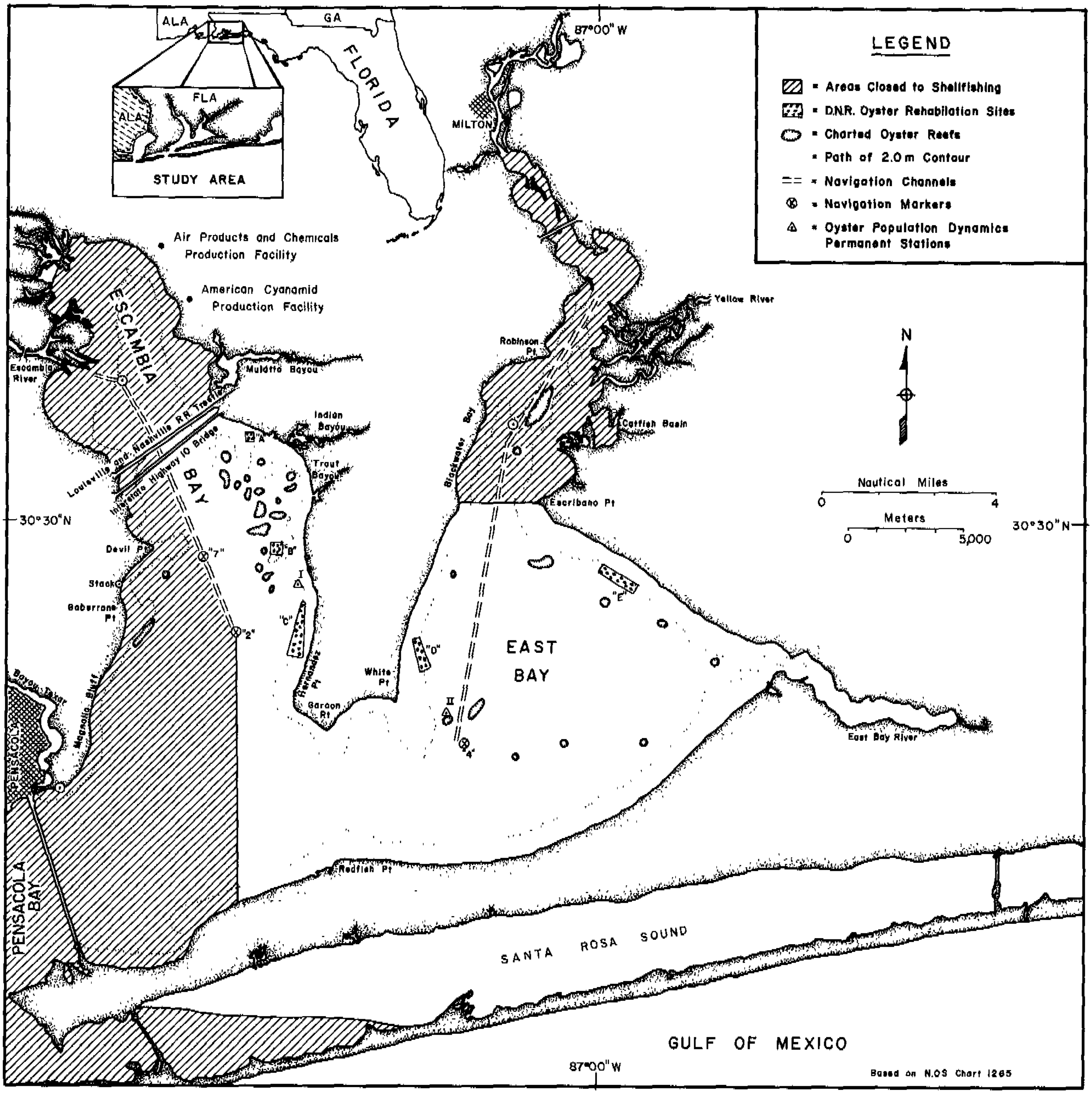

Figure 1. Site plan of the Pensacola Estuary.

areas of the bay commonly experienced severe dissolved oxygen deficiencies (Gallagher, 1971) and fish kills have frequently resulted (Young, 1971). Beginning about 1969, marked contamination by the polychlorinated biphenyl (PCB) Aroclor 1254 occurred, particularly in sediments (Duke et al., 1970). Residues of DDT have been commonly found in East Bay oysters, but levels have recently been low (Butler, 1973). Excessively high concentrations of fecal coliform bacteria in north and west Escambia Bay and in Blackwater Bay have caused these areas to be closed to shellfish harvesting. Government and industry are now working to abate major sources of pollution, but effects on the ecosystem, although decreasing in severity, may persist.

Escambia Bay hydrography is characterized by a net southward flow of river waters along the western shore and by intrusion of more saline waters

TABLE 1. RECENT PENSACOLA CLIMATOLOGICAL DATA
(N.W.S. HAGLER FIELD OBSERVATIONS)

	Precipitation (in)				Temperature (F°)			
	1971	1972	1973	Normal	1971	1972	1973	Normal
January	1.61	3.65	3.93	4.22	53.2	58.7	52.2	53.5
February	5.43	3.48	4.74	4.25	53.8	55.1	52.2	56.1
March	3.05	5.55	11.81	6.04	58.0	61.3	64.6	61.0
April	.67	2.04	7.88	5.25	66.8	68.8	65.7	67.9
May	3.92	4.58	3.79	4.56	73.2	74.1	75.0	75.5
June	5.10	8.54	3.45	5.43	81.0	81.1	81.9	81.1
July	6.53	3.58	12.92	8.02	81.6	79.2	84.3	81.7
August	7.27	8.10	4.14	6.97	81.0	83.9	82.4	81.5
September	4.91	1.66	6.13	7.69	79.0	82.2	80.6	78.2
October	T.*	4.45	3.97	2.98	73.5	71.6	73.4	70.4
November	2.37	5.67	1.98	3.24	60.2	58.3	66.1	59.5
December	3.71	5.22	7.68	4.22	63.0	56.7	53.9	54.3
TOTAL	44.5	51.5	72.42	62.8				

* Trace

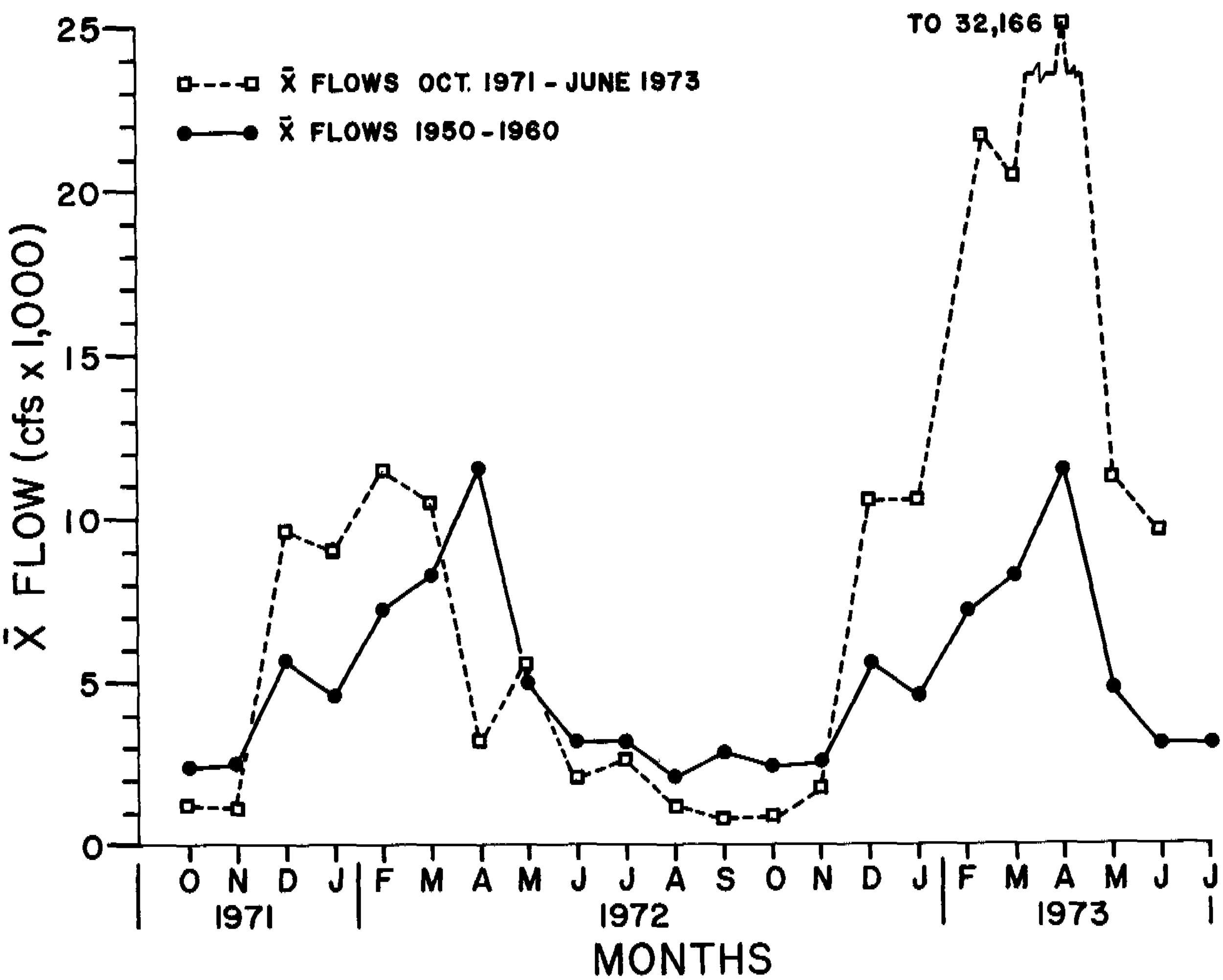

Figure 2. Mean monthly flow of Escambia River, October 1971 through July 1973, compared with means of 1950-1960.

northward along the eastern shore (Gallagher, 1971; EPA, 1971a). An estimated 18.8% of the Bay's volume is exchanged each tidal cycle and flushing is calculated to occur every eighteen days (EPA, 1971a). The hydrography of East Bay is less well known, but it seems to follow patterns noted for Escambia Bay; river flows, prevailing winds, and tides probably establish a similar net counterclockwise circulation (Gallagher, 1971).

METHODS AND MATERIALS

RECONNAISSANCE SURVEY

Several types of stations were established in Escambia Bay, East Bay, and Santa Rosa Sound, depending on data sought. These were designated as substrate, ecological, and oyster population dynamics stations. Substrate stations were sampled once and were used to locate bottoms suitable for shell planting. Station spacing was irregular, but generally was closest over bottoms suspected to be actually or potentially productive of oysters. Bottom depth, firmness and topography were determined by probing with a 4.0 m long ruled wooden pole. Substrate samples were retrieved with oyster tongs and grossly categorized as sand, silty sand, soft silty mud, and oysters or shell fragments.

Ecological sampling stations permitted investigation of oyster abundance, size, and assessment of fouling and predation. Hydrographic data (to supplement that reported by Gallagher, 1971) and substrate data were also taken. These stations were less numerous than substrate stations, were sampled only once, and were established near oyster reefs or on bottoms believed firm enough to support artificial oyster reefs.

At each ecological station, surface and bottom water samples were taken with a pull-stopper water bottle for immediate determination of salinity (refractometer), temperature, and dissolved oxygen (YSI model 51 D.O. meter). Secchi visibility was recorded and surface pH was determined later in the laboratory with a Corning model 10 pH meter. Samples of approximately one-half to one bushel of oysters or oyster shells were tonged for analysis of oyster abundance, size distribution, mortality, predation, recruitment, relative growth, and prevalence of fouling organisms.

Abundance was quantified by the rate at which commercial size (≥3 inches [7.62 cm] height) oysters were obtained with oyster tongs as follows: numerous (N;≥8 oysters/min), common (C;5-7 oysters/min), occasional (O;2-4 oysters/min), scarce (S;≤1 oyster/min), or not evident (NE). Criteria were established by determining the rate of oyster yield from a very productive but unharvested reef in western Escambia Bay and from commerical reefs in other portions of East and Escambia Bays.

Size distribution was determined by noting numbers of oysters in samples in each of the several size categories used by Hofstetter (1966) for Galveston Bay oysters. These categories were: "spat" (0.5-25 mm), "seed" (26-50 mm), "submarket" (51-75 mm), "market" (76-100 mm), and "large market" (≥101 mm).

Recent oyster mortalities, particularly of the September 1971 kill, were estimated by percent of clean, unfouled, unstained "boxes", (still articulated empty oyster shells) in tong samples as follows: ≤40% boxes (normal), 41-70% boxes (excessive); 71-100% boxes (extensive). The method has many imperfections (Mackin, 1961; Quick and Mackin, 1971; May, 1972), but was of necessity applied to give general estimates during the reconnaissance. Shells were also examined for oyster predators or their characteristic shell damage. Evidence of oyster drills, *Thais haemastoma floridana* (Conrad) (see Butler, 1954a; McGraw and Gunter, 1972), blue crabs, *Callinectes sapidus* Rathbun (see Menzel and Hopkins, 1954), stone crabs, *Menippe mercenaria* Say (see Menzel and Hopkins, 1954), and small xanthid crabs such as *Eurypanopeus depressus* (Smith) (see Menzel and Hopkins, 1954; McDermott, 1960) was particularly sought.

Inspection of boxes from recent oyster deaths yielded information on setting, survival, and growth of seed oysters and spat. Spat sets on shell exteriors were usually negligible, but box interiors often remained clean and attracted spat for several months. For each station, samples of several boxes were examined under a dissecting microscope and spat abundance was categorized (Table 2).

Samples of 10-25 oysters and/or oyster valves from each ecological station were examined to determine abundance and species composition of attached fouling organisms and oyster associates. Such organisms, when numerous, compete with oysters for setting space and food (Churchill, 1920; Pearse and Wharton, 1938; Galtsoff, 1964) and complicate culling and cleaning of oysters for market. Comparison of relative fouler prevalence in samples throughout Escambia and East Bays served as criteria for formulating abundance categories (Table 2). These categories were specific only to the Pensacola estuarine system because of the uncommonly low prevalence of foulers during

TABLE 2. CATEGORIES OF ABUNDANCE (NUMBER OR PERCENT COVERAGE) OF SPAT AND PRINCIPAL FOULERS ON OYSTERS OR RECENT BOXES OR PER TWO HALF SHELLS

Organisms	Not Evident (-)	Scarce (X)	Occasional to Common (XX)	Numerous to Abundant (XXX)
Crassostrea virginica (Gmelin) Spat per shell	0	0-1	2-3	4 or more
Crepidula plana Say *C. fornicata* (Linne) Slipper shells	0	1-2	3-6	7 or more
Balanus eburneus Gould Barnacles	0	1-2	3-7	8 or more
Ischadium recurvum (Rafinesque) Mussels	0	1-2	3-7	8 or more
Cliona spp. Boring sponge (% of pitting)	0%	to 5%	6-15%	16% or more
Hydroids (% coverage) Unidentified sp.	0%	to 5%	6 - 15%	16% or more
Polydora websteri Hartman Polydora worms (% of pitting)	0%	to 5%	6-20%	21% or more
Eupomatus dianthus (Verrill) Serpulid worm tubes (% coverage)	0%	to 5%	6-25%	26% or more
Membranipora tunuis Desor Bryozoa (% encrusted)	0%	to 5%	6-25%	26% or more

the reconnaissance survey.

Twelve oysters collected from each of the two oyster population dynamics stations (Figure 1) were assayed quantitatively for *Labyrinthomyxa marina* and related parasites using Ray's (1953) fluid thioglycollate medium (F.T.M.) as modified and described by Quick (1972). Intensities of infections were quantitated as described in Quick and Mackin (1971). These estimates were averaged for each sample to produce a number reflecting the proportion of the population infected and the intensity of infections. This "weighted incidence" (W.I.) is useful in comparing infections in oyster populations (Quick and Mackin, 1971). Conditions of meats of these oysters were rated by the method of Quick and Mackin (1971). External sculpture of shells of these oysters and those of oysters from other stations in East and Escambia Bays was evaluated using methods of Quick and Mackin (1971) to determine patterns of recruitment, age, growth, mortality, and incidence of spawning.

REHABILITATION PROGRAMS

CONSTRUCTION OF SHELL REEFS

Based on reconnaissance findings, five sites (Figure 1) were selected in March 1972 for rehabilitation. Each was marked by erecting 15 cm diameter creosoted wooden pilings at the corners. Sites A, B, and C were situated on meandering zones of firm, silty sand in waters 2.0-3.0 m deep off the eastern shore of Escambia Bay. Sites D and E were situated on comparable bottoms off the western and eastern shores of East Bay. Salinities and temperatures at these sites were measured whenever possible through the next two years, but intensive hydrographic sampling was impractical.

Construction of shell reefs at these sites began in April 1972 and continued intermittently through June 1973 as shell availability and weather allowed. Shell cultch was placed on bay bottoms to provide clean, hard surfaces to attract natural setting of oyster larvae. Similar methods have been recommended for oyster cultivation by Galtsoff (1943), and Pollard (1973), and have been used by the State of Florida since 1949 (Whitfield, 1973). Shell barges, tugboats, and draglines were contracted from Radcliff Materials Company, Mobile, Alabama.

The first thirteen of 452 shell piles were constructed of Mobile Bay oyster mud shell, but supply problems and the tendency for piles to become too firm for efficient tonging (due to compaction of fine shell fragments) ruled out further use. Shells of the brackish water clam, *Rangia cuneata* (Grey), mined in Louisiana and averaging 25-45 mm in height were used to construct the remaining 439 shell piles. Such shell contains fewer fine fragments and is an excellent cultch (Schaffer, 1972). It is also one of the few materials available along the Gulf coast in quantities sufficient for large-scale oyster rehabilitation (Pollard, 1973).

A typical planting operation required one day and utilized two or three bargeloads of shells (approximately 765 m^3/barge). A barge-mounted dragline was moored abreast of a shell barge and the entire tow was then held stationary on the area selected for planting by lowering pilings or "spuds" into the bottom (Figure 3). Shell was unloaded using a 3 m^3 dragline bucket to form conical piles of the volume desired. Most piles contained 31-54 m^3 of shell and rose 1-2 m above the bottom, but larger and smaller experimental piles were also constructed. Four shell piles were generally planted in a row parallel to the dragline barge each time the tow was positioned. The tow was advanced or otherwise maneuvered until all shell had been planted.

Shell was always planted in mounds rather than being scattered across the bottom because scattered shells would quickly sink under the 2-8 cm of soft mud that covered even the firmest bottoms. Thin layers of scattered clam shells are undesirable since they do not catch spat for as long a period as does mounded shell (Pollard, 1973). Spatfall in East and Escambia Bays was known to be generally meager and erratic (Brice, 1898; Prytherch, 1933; Quick, 1971), so prolonged cultch usefulness would help obtain adequate oyster sets. Mounded shell also has the advantage of forming self-perpetuating, minimal maintenance, public reefs (Whitfield, 1973) which, in event of massive seed oyster mortalities or spatfall failures, remain available to catch spat when suitable conditions return.

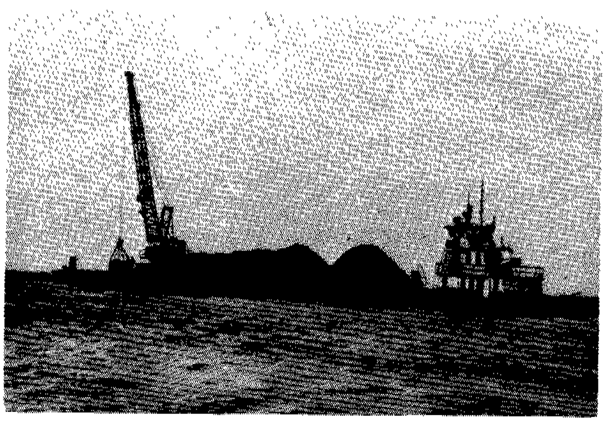

Figure 3. Shell barges, crane barge, and towboat for planting shell.

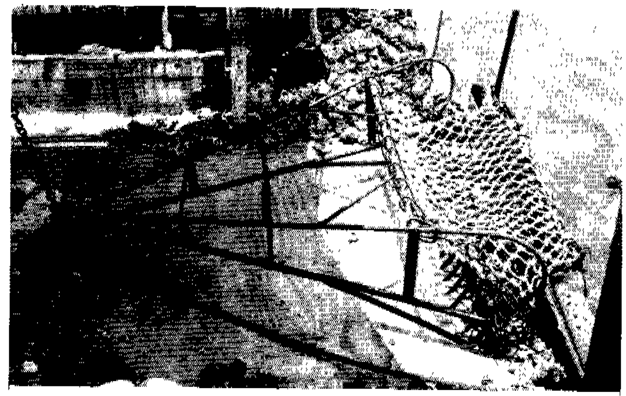

Figure 4. Relaying operations aboard the *Fair Tide*, showing dredge used to collect oysters.

OYSTER RELAYING

Transplanting of oysters to selected rehabilitation sites was undertaken in May 1972 to provide oystermen with readily harvestable stocks, thus augmenting meager yields expected in 1972-1973 as a result of the 1971 oyster epizootic. Private vessels were paid $0.40 per bushel (0.03 m^3) to dredge oysters (Figure 4) from polluted waters of western Escambia Bay and replant them on the three Escambia Bay rehabilitation sites. Department biologists aboard each private relaying vessel calculated volumes of materials relayed, specified harvest and relay areas, suggested techniques to minimize oyster damage and loss, and insured that at least 90% of relayed material was either live oysters or shell with spat attached.

Despite solicitation, only two vessels entered the relay program. Deeper subtidal oyster reefs of western Escambia Bay were fished by the *Fair Tide*, a 47 ft bay trawler equipped with dual four-bushel capacity dredges. In the confines of Bayou Texar (Figure 1), the *Sea Farmer*, a rectangular, flat-bottomed 37 ft oyster barge, worked with a single three-bushel dredge. A similar boat, the *Mary Alice*, was used for several days to tong dense oyster beds in Bayou Texar. On all boats, oysters were unloaded and spread over rehabilitation sites primarily by hand-shoveling.

All oyster harvesting in Escambia Bay was suspended during relaying, for 30 days thereafter, and through the normally closed season. Relayed oysters were expected to depurate within this period. Such relaying of oysters from polluted to clean waters is common along the Gulf (Schaffer, 1972; Tarver and Dugas, 1973) and Atlantic coasts (Gracy and Kieth, 1972).

SPATFALL AND CULTCH MONITORING

Several shell piles were selected for continuing observation of spatfall, siltation, and fouling. Such information is essential to rehabilitation management. Samples of several hundred shells from outer, exposed surfaces of these piles were collected monthly by tonging or diving and given cursory field examination. Smaller portions of 10-25 shells each were retained from such samples and examined microscopically for spat abundance. Observations were considered valid only for the immediate locality sampled since spat distribution is known to vary greatly over short distances (Hidu and Haskin, 1971).

Beginning in April 1972, spatfall and fouling were also measured with cement board tiles. Methods and materials used were similar to those of Butler (1955), Shaw (1967), and Hidu and Haskin (1971). Smooth 10 x 10 cm tiles were wedged into weighted wooden frames (Figure 5) and suspended approximately 30 cm above bay bottom. The two tiles in each frame were kept 10 mm apart by wooden pegs so that four horizontal surfaces were presented for setting of oyster spat and fouling organisms. Upper sides of both tiles were designated as surfaces I and III, and lower sides as surfaces II and IV. One frame was placed in Escambia Bay at site C (water depth $\simeq$ 2.5 m) and the other was placed in East Bay at site D (water depth $\simeq$ 2.6 m), both being within 20 m of shell piles.

Effectiveness of these collector materials and methods was tested by placing a third collector in Santa Rosa Sound, a locality of profuse and extensively monitored spatfall (Butler, 1955, 1965). From July through October 1972, this collector was suspended 30 cm above bottom in 2.5 m of water at the east dock of the Gulf Breeze Environmental Research Laboratory.

Efforts were made to replace exposed tiles every two weeks on all collectors, but inclement weather and scheduling conflicts often interferred. Nevertheless, most were replaced at intervals within one to three weeks.

Exposed tiles were examined under a dissecting microscope at 60X magnification. An etched glass grid overlay delimited each tile surface into 100 squares of 1.0 cm^2. Total number of attached spat and foulers was approximated by scanning diagonally across the grid and counting respective numbers of organisms in each of the ten grid squares. If the total for any organism was less than 100, that organism was counted in the remaining 90 grid squares in order to arrive at a more accurate enumeration. Upper and lower surfaces of both tiles deployed at each site were examined. All tiles were labeled and saved for future reference.

RESULTS AND DISCUSSION

RECONNAISSANCE SURVEY

Information on bottom topography and hydrographic/biological characteristics during the reconnaissance survey are presented in Appendices I and II. More bottom area was probed and tonged than is indicated by the listing of stations in these appendices. In most cases stations served as control points for recording topographic observations found representative of a wide area of adjacent bottom. Local rainfall during this period was subnormal (Table 1), while, Escambia River flows (due perhaps to the extensive drainage basin) were above average (Figure 2). Furthermore, salinity values may be somewhat misleading due to short-term tidal fluctuations typical of this bay system (Cooley, in press). Ecological observations are likewise provisional since severe mortalities of fishes and invertebrates shortly preceded this study (Quick, 1971; Young, 1971), and most observations were made during cooler periods of the year.

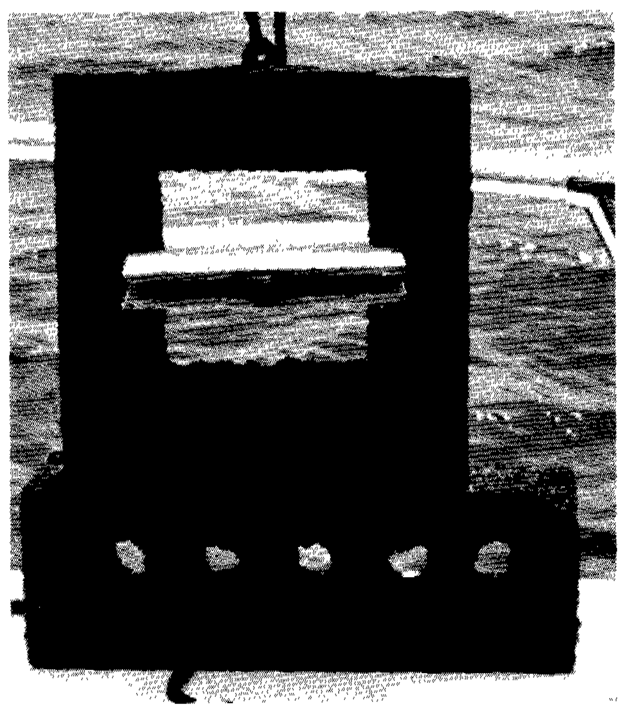

Figure 5. Spat collector with two newly inserted tiles ready to be suspended underwater.

Oysters generally grew in two types of habitats. Market and submarket "reefer" oysters occurred on the sloping sand-mud transition zone in small scattered clusters, but these were seldom sufficiently abundant for commercial tonging. In deeper offshore bay waters, isolated moundlike shell reefs rose 0.5-1.0 m above surrounding mud bottoms. These produced market and large-market single cup oysters with characteristically rounded valves in densities suitable for commercial tong harvest. Such oysters were sold locally for the half-shell trade, since repeatedly poor harvests had caused shucking and packing houses to suspend operations the last few years.

Unlike many Gulf estuaries, shallows of East and Escambia Bays are devoid of intertidal bars of stunted "coon" oysters. Shifting sand bottoms and marked wave energies prevalent along most exposed bay shorelines probably combine to inhibit development of such bars. Non-commercial crested oysters, *Ostrea equestris* Say, abundant in the more saline water of Santa Rosa Sound (Mensel, 1954), were absent in East and Escambia Bays during the reconnaissance survey.

To facilitate data presentation, East and Escambia Bays have been divided by parallel 30°30′ N into the following sectors: northern Escambia Bay, southern Esiambia Bay, Blackwater Bay, and East Bay. These closely conform to boundaries of the respective areas where rehabilitation was foune o be either impractical (northern Escambia Bay, Blackwater Bay) or practical (southern Escambia Bay, East Bay). Two additional areas, Bayou Texar and Santa Rosa Sound, investigated as sources of seed oysters, are also described.

NORTHERN ESCAMBIA BAY

Most of northern Escambia Bay (Figure 6) was closed to shell fishing because of continuing fecal coliform bacterial contamination. An approved area was located in the southeast corner, but most usable firm bottom there was already privately leased.

Extensive siltation (Horvath, 1968) has rendered most northern Escambia Bay bottom too soft for cultch planting. A few scattered shell reefs and some buried shell depostis lie west of Indian Bayou (Radcliff Materials Corporation, 1967), but oyster production on these reefs has almost ceased and only a few outcroppings now protrude above often thick blankets of silt. The nearshore, unvegetated, sand-mud transition zone is indistinct even though the sandy shallows are just as extensive as elsewhere in the estuary.

Proximity to the Escambia River greatly modified hydrography (Table 3). At normal flows, bottom salinities at the river mouth average near 20 ‰. However, during high discharge in January 1972 surface salinities were reduced to less than 1.0 ‰ as far south as Indian Bayou during a two-week period. Salinities off Indian Bayou during this study averaged 20.3 ‰ (surface) and 23.4 ‰ (bottom), while values above the Louisville and Nashville Railroad trestle average 10.1 ‰ (surface) and 22.1 ‰ (bottom). During a comparable period in 1970, Gallagher (1971) reported prevailing values of 10.1 ‰ (surface) and 15.0-20.0 ‰ (bottom) for northern Escambia Bay.

Bottom dissolved oxygen concentrations ranged from 3.0-8.3 mg/l ($\bar{x}$ = 6.6 mg/l) and were usually lower than surface values ($\bar{x}$ = 8.5 mg/l) throughout the survey period. Depressed bottom D.O. (≤ 53% saturation) was also noted by Gallagher (1971) in this area during September 1970. Depression of bottom D.O. below 4.0 mg/l likewise prevailed in September 1969, probably as a consequence of oxygen-demanding organic sediments (FWPCA, 1970). Our daylight measurements and Gallagher's autumn values are not representative of the depressed D.O. that would be expected to occur at night, especially during summer. Recurrent fish kills in the summer of 1969 and 1970 were caused in part by such low D.O. (Hopkins, 1969; FWPCA, 1970).

Surface pH in northern Escambia Bay ranged 6.0-8.3 and averaged 7.5. In January, readings decreased to 6.0 and 6.3 at stations E-74 and E-75, possibly as a result of high river discharge. A surface pH range of 6.9-8.2 and a bottom pH range of 7.1-8.1 were reported for northern Escambia Bay in autumn 1970 by Gallagher (1971).

The only significant concentration of oysters found in northern Escambia Bay was at station E-75 off Indian Bayou. These were scattered on a small, severely silted natural reef approximately 10 m in diameter in 2 m of water. Despite thorough tonging, only ten spat and seed oysters, 18-37 mm in height ($\bar{x}$ = 25 mm), and one market oyster (76 mm height) were found on shell fragments. The spat had evidently set in autumn 1971, but the overall scarcity of oysters indicated marginal setting and growing conditions in recent years.

Oyster associates were seldom encountered in northern Escambia Bay, due primarily to excessive sedimentation and lack of suitable hard substrate. On shell outcroppings at station E-75, barnacles, *Balanus eburneus*, averaged 7-9 mm in diameter but were scarce; mussels, *Ischadium recurvum*,

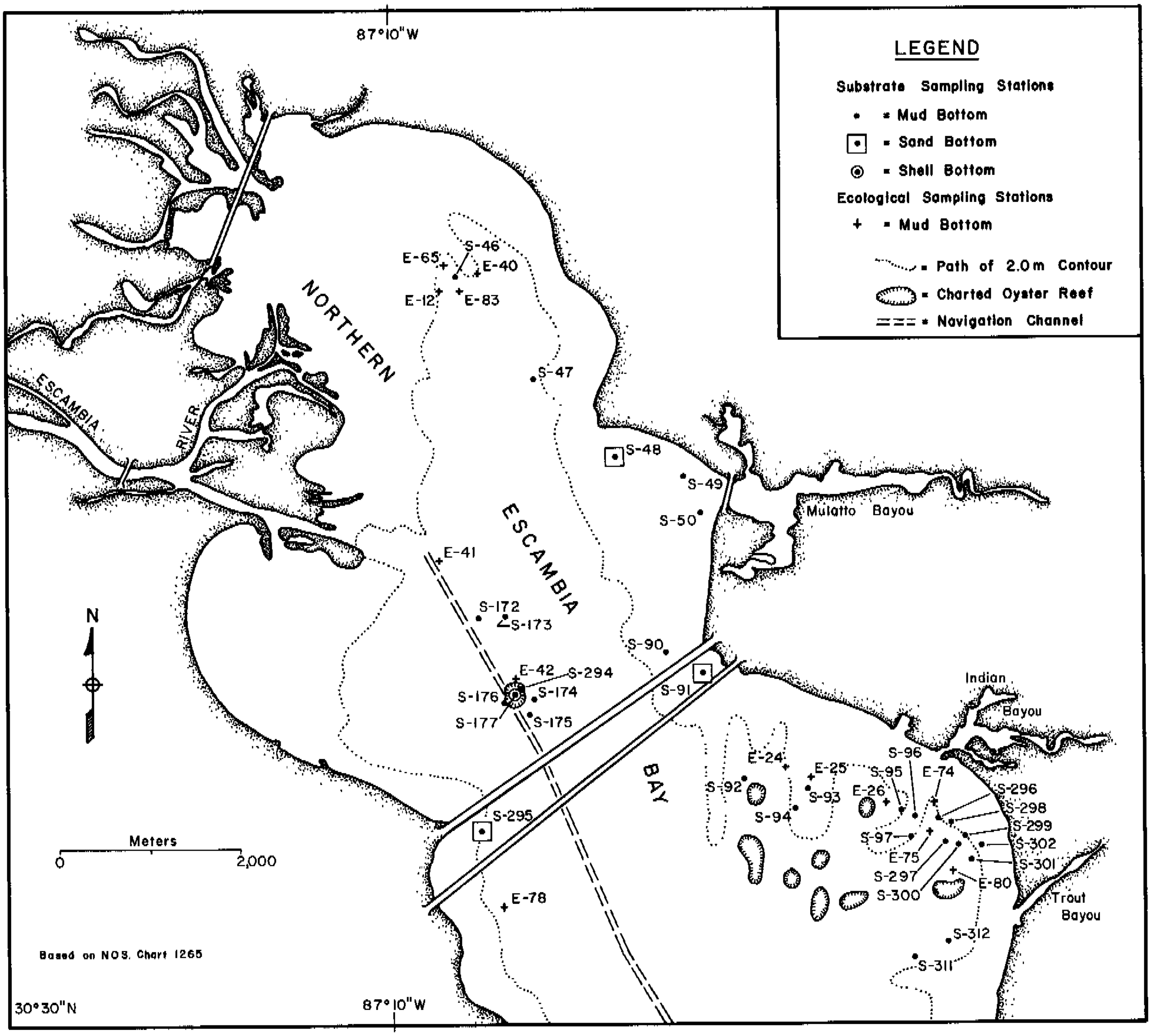

Figure 6. Reconnaissance survey stations, northern Escambia Bay.

($\bar{x}$ = 20 mm height) commonly occurred 2 4 per shell fragment, although some clusters of up to 20 per shell were noted. Serpulid worm tubes and *Membranipora* encrustations were light to moderate. Other oyster associates commonly found elsewhere in the estuary were not evident, presumably due to low salinities.

It appears that although hydrological and ecological conditions allow some oysters to survive in northern Escambia Bay, resource rehabilitation would be impractical there due to pollution, excessive siltation, paucity of suitable bottom, and freshwater flooding.

SOUTHERN ESCAMBIA BAY

Although most of southern Escambia Bay (Figure 7) is floored by soft, silty mud (Horvath, 1968), exposed and buried oyster reefs are common (NOS Chart, 1265; Radcliff Materials Corporation, 1967). Western portions of the Bay receive effluent from the Pensacola Municipal Northeast Sewage Treatment Plant (FWPCA, 1970) and only waters east of the navigaiton channel are open to shellfish harvesting.

Off the eastern shore, many scattered oyster

TABLE 3. SUMMARY OF HYDROLOGICAL DATA OCTOBER 1971 THROUGH FEBRUARY 1972

Locality		Salinity range ‰	Salinity mean ‰	Temperature range °C	Temp. mean °C	D.O. ppm range	D.O. ppm mean	pH range	pH mean
Northern Escambia	S	1.0-27.0	15.2	14.4-24.6	16.5	7.0-10.0	8.5	6.0-8.3	7.5
Bay	B	15.0-27.0	22.7	13.0-24.3	16.2	3.0- 8.3	6.6	NT	NT
Southern Escambia	S	3.3-26.5	17.2	10.3-25.6	19.6	6.3-10.4	7.7	6.9-8.2	7.8
Bay, Western side	B	10.0-28.0	24.0	13.0-26.0	20.0	4.3- 9.8	6.8	NT	NT
Southern Escambia	S	1.0-30.0	20.5	12.0-25.5	17.2	4.8-10.2	7.9	5.5-9.0	7.3
Bay, Eastern side	B	16.6-31.0	25.0	11.5-25.3	17.0	3.1- 9.0	6.9	NT	NT
Blackwater Bay	S	3.2-24.3	13.5	11.5-24.6	20.0	5.8-10.6	7.4	6.8-8.1	7.5
	B	10.7-25.1	17.0	12.3-24.2	19.8	4.3- 9.0	6.4	NT	NT
East Bay	S	1.0-28.0	16.9	12.5-25.9	18.8	6.3-10.2	8.0	5.5-8.4	7.5
Western side	B	8.6-30.0	22.7	12.5-26.0	18.1	5.4-11.2	7.6	NT	NT
East Bay	S	11.8-30.0	20.7	12.5-25.0	17.1	6.0-10.0	8.1	5.2-8.7	7.3
Eastern side	B	12.9-20.0	22.2	12.0-25.2	17.0	2.4-10.0	7.1	NT	NT
Bayou Texar	S	11.8-25.2	17.8	12.2-23.0	17.8	5.4- 9.0	6.5	8.1-8.6	8.3
	B	16.1-25.0	18.5	9.0-21.5	20.6	4.8- 7.0	6.1	NT	NT
Santa Rosa	S	22.6-24.7	23.3	19.5-20.0	19.6	7.2- 7.8	7.4	7.2-7.8	7.5
Sound	B	23.6-24.7	23.3	18.5-19.6	19.1	6.8- 7.8	7.3	NT	NT

S = surface
B = bottom
NT = not taken.

reefs and shell deposits were found from Trout Bayou southward to just north of Hernandez Point. About 60 acres (24 hectares) were exposed as hard bottom. Clusters of oysters grew 100-150 m offshore on the narrow (average width 50 m) winding sand-mud transition zone in depths of approximately 2.5 m. It was in this area that highest mortalities occurred in September 1971 (Young, 1971; Quick, 1971); in addition to natural losses, oysters were killed on over 400 acres of leased bottoms along northeastern Escambia Bay. Oysters occurred sporadically on littoral debris. Seagrasses were absent from the sandy flats.

In western portions of southern Escambia Bay, several reefs of about 12 hectares total area rise .5 m - 1.0 m above the mud bottoms in the bight of Devil Point. Another series of narrower reefs extend from Gaberrone Point to near Magnolia Point. Just inshore of these latter reefs, the sand-mud transition zone rises quite abruptly to the sandy inshore flats. Most western shore reefs were dredged in summer 1971 to supply oysters for relay onto private leases and public oyster beds in northeastern and southeastern Escambia Bay.

Hydrological data (Table 3) were taken at nine stations on the western side of southern Escambia Bay and at sixteen stations on the eastern side. Most hydrological parameters appeared compatible with oyster rehabilitation needs. Bottom salinities averaged approximately 24.5 ‰, but values as low as 10.0 ‰ occurred during maximal river discharge. Similar hydrography was reported by Gallagher (1971) for the area during September through December 1970. In limited sampling during June and July 1971, Gallagher (unpublished data) found salinities ≥ 25 ‰ prevalent in June and < 15.0 ‰ after July freshets. He also found depressed bottom D.O. during June and July throughout south Escambia Bay.

Southern Escambia Bay oyster populations were generally depauperate. Market oysters were found in only a few localized areas, such as the western shore beds (Table 4) and reefs of the southernmost east shore (Table 5). Although the September 1971 kill occurred in these areas, no fresh boxes or "gapers" were evident during our survey. Mortality appeared to be low, perhaps because spat and oysters usually suffer fewer mortalities during winter than in summer (Quick and Mackin, 1971; May, 1972).

Seed oysters, small submarket oysters, and even boxes of smaller oysters were scarce at all stations, thus indicating spawning failure, poor spat setting, and/or poor survival in the recent past. According to commerical oysterman Albert Pearson (personal communication), the moderate spatfall following the 1971 epizootic, although light, was the heaviest noted in recent years. This situation is the reverse of that in most Gulf estuaries where numerous small oysters and fewer market oysters are the rule, due to constant high spatfall followed by high predation and disease attrition (Hofstetter, 1966; May and Bland, 1969, Quick and Mackin, 1971).

We found no spat in southern Escambia Bay until November 11, 1971, when three ($\bar{x}$ = 10 mm height) were taken from a ¼ bushel sample of shell at station E-27. Spat may have been overlooked in prior samples or, as Quick (1971) noted in September shell samples, none had set. As the survey progressed, spat became larger and more numerous (Tables 4, 5). Spat never became abundant in Escambia Bay shell samples (average one spat per oyster), whereas samples from Santa Rosa Sound, typically a heavy setting area, averaged eight spat per oyster.

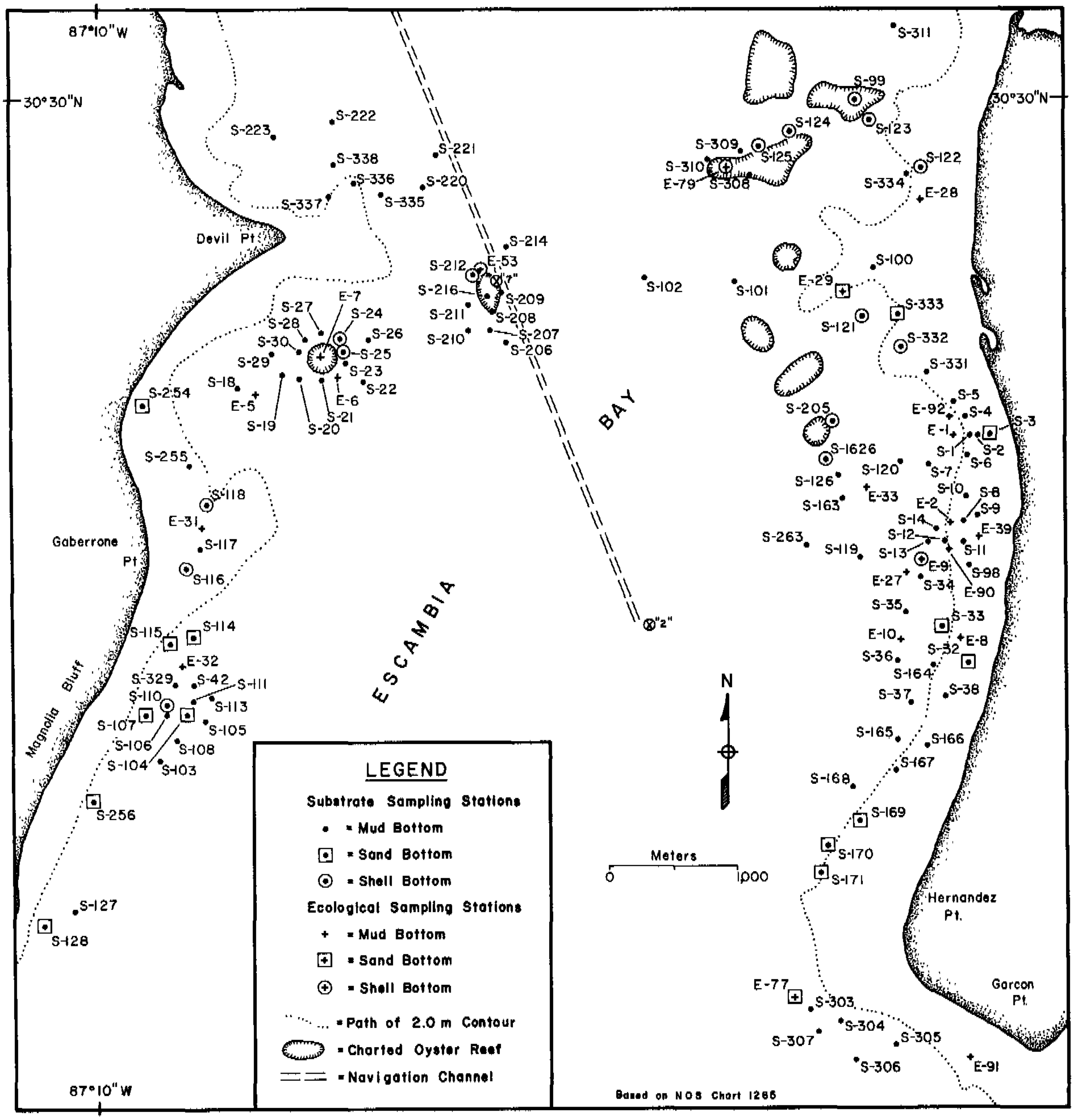

Figure 7. Reconnaissance survey stations, southern Escambia Bay.

TABLE 4. ECOLOGICAL DATA, WESTERN PORTIONS OF ESCAMBIA BAY, OCTOBER 1971 THROUGH FEBRUARY 1972 *

Station	E-7	E-30	E-31	E-32	E-53	E-60	E-89
Date	10/24	11/11	11/11	11/13	12/12	12/21	2/5
Depth (m)	2.1	2.1	2.7	2.4	1.8	2.4	2.1
% oysters in sample	20%	30%	20%	10%	10%	40%	20%
Market oysters	C	O	S	NE	S	N	S
Sub-market oysters	O	C	O	S	S	N	S
Seed oysters	S	NE	NE	NE	S	S	NE
Spat					XXX	XX	XX
Spat sizes range + $\bar{x}$					7-40 mm $\bar{x}$ = 20mm	10-16mm $\bar{x}$ = 15mm	3-32 mm $\bar{x}$ = 12mm
Barnacles	XX	X	XX	X	XXX	XX	XXX
Mussels	X	X	XX	X	XXX	XXX	XX
Crepidula Slipper shells						X	X
Bryozoa					XX	XX	X
Serpulid tubes					X	X	X
Polydora borings			XX		X	X	X
Cliona borings							
Hydroids							

* N ≥ 8 oysters/min; C = 5-7 oysters/min; O = 2-4 oysters/min; S ≤ 1 oyster/min; NE = not evident. See Table 2 for spat and fouling organism abundance code.

Spat were relatively scarce throughout southern Escambia Bay except at Station E-53. Here, thirteen valves and boxes bore 75 spat and recently set seed oysters ranging from 7-60 mm in height ($\bar{x}$ = 22 mm) for a density of about six per shell. Submarket oysters were scarce; the few tonged at E-53 evidently set in spring 1971. The western Escambia Bay reef, where E-53 was located, had been closed to tonging for many years, and rose almost 2.0 m above surrounding silty bottoms. Possibly, increased wave action and currents kept shells on the upper reef free of sediment, thus promoting greater than average spatfall.

Investigation of distribution and abundance of various oyster associates (Tables 4, 5) was inconclusive due to the limited survey period, but some general trends were evident. It appears that fouling is slight throughout most of southern Escambia Bay and should not greatly limit utility of cultch plantings. Perhaps due to greater intrusion of more saline waters along the eastern shore, oyster associates were more common on oyster reefs there than on those off the western shore. Higher salinity waters characteristically support greater and more diverse fouler assemblages than do brackish waters (Gunter, 1955; Wells, 1961). Principal foulers at all stations were barnacles, *Balanus eburneus*, and mussels, *Ischadium recurvum*. Both were occasionally numerous, and some setting occurred throughout the survey period. Other oyster associates included boring sponge, *Cliona* sp., encrusting bryozoa, *Membranipora tenuis*, oyster mud worms, *Polydora websterii*, slipper shells, *Crepidula fornicata* and *C. plana*, and serpulid worms, *Eupomatus dianthus*. All were generally present in numbers too low to inhibit oyster setting.

Few oyster predators were observed in southern Escambia Bay during the reconnaissance survey. Unexpectedly, no oyster drills, *Thais haemastoma floridana* or stone crabs, *Menippe mercenaria*, were found. Small xanthid mud crabs, *Eurypanopeus depressus* and *Neopanope texana sayi*, occurred in most samples. McDermott (1960) found these crabs and other small xanthids cause considerable mortalities of small oysters and barnacles. Blue crabs and other portunids were occasionally seen. A few oyster leeches, *Stylochus* sp., were in some shell samples.

In summary, areas of firm bottom were not extensive in southern Escambia Bay, but hydrological and ecological conditions were amenable for implementation of oyster rehabilitation. Although oyster populations had been depleted by the September 1971 epizootic and by poor spatfall in previous years, the moderate autumn 1971 spatfall indicated that recovery was possible. Oyster associates and oyster predators were seldom abundant and should not be limiting to rehabilitation.

BLACKWATER BAY

Blackwater Bay (Figure 8) above Escribano Point is closed to shellfish harvesting. Except for a few partially buried reefs, the bottom is generally soft silty mud. Deepest waters ($\bar{x}$ depth 3.0 m) are in the navigation channel, which runs northward to Milton, while shallow sandy flats extend shoreward. Unlike in East Bay and Southern Escambia Bay, marine grasses, *Ruppia maritima* (Linné), sedges, and cattails grow profusely inshore. During the reconnaissance survey, the few small oyster reefs present were evaluated as sources of oysters for relaying to approved areas of East Bay.

Although discharges of the Blackwater, Yellow, and Shoal Rivers undoubtedly moderate hydrology of Blackwater Bay (Table 3), marine influences are strong. Bottom salinities as high as 13 ‰ penetrated beyond the Interstate Highway 10 bridge during October 1971. Gallagher (1971) likewise found intrusion of saltwater beyond Catfish Basin from October to December 1970. In February 1972, however, river discharges increased and bottom salinities decreased to 10.7 ‰ as far south as Escribano Point. During the survey, average difference between surface and bottom salinities at the six hydrological stations was 5.2 ‰. Other hydrological parameters measured were unremarkable.

Oyster populations in Blackwater Bay seemed depauperate; few market or submarket oysters

TABLE 5. ECOLOGICAL DATA, EASTERN PORTIONS OF ESCAMBIA BAY OCTOBER 1971 THROUGH FEBRUARY 1972 *

Station	E-9	E-27	E-33	E-39	E-59	E-79	E-90	E-92
Date	10/29	11/11	11/14	11/25	12/21	1/21	2/8	2/9
Depth (m)	2.5	2.4	2.7	2.5	2.5	2.1	2.1	2.2
% oysters in sample	20%	20%	20%	10%	20%	30%	40%	50%
Market oysters	O	S	NE	S	S	O	S	S
Sub-market oysters	NE	O	NE	S	S	S	S	NE
Seed oysters	NE	NE	NE	NE	NE	NE	NE	NE
Spat		X	XX	XX	XX	X	X	X
Spat sizes range + $\bar{x}$		8-15mm 10mm	20-30mm 20mm	3-13mm 8mm	5-22mm 20mm	6-32mm 22mm	7-32mm 18mm	10-30mm 25mm
Barnacles	XX	XX	XXX	X	XXX	XXX	XX	XX
Mussels	XXX	XX	XXX	XX	XX	XX	XX	XX
Crepidula Slipper shells					XX		X	
Bryozoa			X		X	XX	X	
Serpulid tubes					X	X	X	X
Polydora borings	X	X	X	X		XX	X	X
Cliona borings	X						X	
Hydroids							X	X

* N ≥ 8 oysters/min; C = 5-7 oysters/min; O = 2-4 oysters/min; S ≤ 1 oyster/min; NE = not evident. See Table 2 for spat and fouling organism abundance code.

were evident. Reefs were confined to the lower half of the bay and were composed of old, eroded shell mixed with soft silty mud. Seed oysters and spat were commonly attached to the few shell outcroppings. Surveys show these reefs to be exposed portions of extensive, but relatively thin deposits of buried shell (Radcliff Materials Corporation, 1967). Recent retarded development of the Blackwater reefs and paucity of market oysters may stem from intermittent flooding. Prytherch (1933) reports that freshets destroyed some Blackwater reefs in the 1930's, and local oystermen state Blackwater reefs were also decimated by floods in the late 1960's. These reefs are apparently repopulated in drought years and then depleted in wet years. Resuspension of bottom sediments by barge traffic may be at least partially responsible for siltation over these bottoms and oyster reefs.

In November 1971, spat of 15-25 mm were common on Blackwater Bay shell samples. By February 1972, spat and seed oysters of 20-30 mm height were numerous. Spat boxes, however, were common indicating approximately 25% attrition of the autumn 1971 spatfall.

Oyster associates were not as profuse in Blackwater Bay as in East Bay. Empty barnacles and clusters of mussel byssal threads attested to diebacks of fouler populations. Medium-sized live barnacles (10-15 mm diameter) were common, but larger and smaller individuals were scarce perhaps indicating a limited setting season. Mussels were numerous on shell clusters, but were chiefly of large (≥30 mm) or medium (≥ 15 mm) size. *Membranipora* encrustations and *Polydora* borings were very abundant. Serpulid worm tubes, *Cliona*, *Crepidula*, and other higher salinity oyster associates were not evident.

Although spat and seed oysters were occasionally numerous on Blackwater Bay reefs, the amount of material suitable for relay was limited. Except for a few outcroppings, reefs were chiefly dead shell covered by a layer of silt less than 30 cm thick. They were generally too small to be of much value as a source of relay purposes.

EAST BAY

Oyster harvesting is permitted in all of East Bay. The bottom is chiefly soft mud with numerous buried shell deposits (NOS Chart, 1265; Radcliff Materials Corporation, 1967). Most scattered living reefs are outcrops of these thick deposits. Sandy shoals ring most of the shoreline out to about 2.0 m. Shoal areas are particularly extensive off Garcon Point, White Point, and Escribano Point. Scattered beds of *Ruppia maritima* occur in the northeastern shallows.

Survey of 35 hydrographic stations indicated (Table 3) oyster rehabilitation was possible in both western (Figure 9) and eastern (Figure 10) portions of East Bay. Salinities in western portions, however, were lowered in January and February 1972 by Blackwater River discharge. Surface and bottom salinities ($\bar{x}$ difference 5.7 ‰) differed more than in less stratified eastern portions ($\bar{x}$ difference 2.2 ‰). Bottom salinities commonly exceeded 20‰ throughout East Bay, and it is likely that even higher, less favorable values could be expected in autumn when fluvial influences would be least. Salinities and other hydrographic features generally corresponded with values noted by Gallagher (1971) and were not unusual.

East Bay oyster populations (Table 6) supported some commercial tonging during the September 1971 through May 1972 oyster season. Although oysters were more numerous than in Escambia Bay, less than half the tonged samples contained market oysters. Recent, lightly fouled boxes noted early in the survey indicated appreciable late summer mortalities.

Commercial oysters were tonged chiefly from a series of adjacent, low, irregular reefs south of Escribano Point (stations E-94 and S-343). In more southerly portions of East Bay, several moundlike reefs were also productive, but by February 1972 intensive tonging had almost depleted them. Additional market oysters were taken from scattered clusters growing on the sand-mud transition zone (depth 2.1 m) off the northeast shore (E-88, S-327, and S-328). Similar bottoms off western and southern shores were generally unproductive. Limited numbers of exceptionally large market oysters grew in scattered clusters on soft mud bottoms between Garcon and White Points (stations E-82 and S-155). Although these oysters and shell clusters were almost completely engulfed by soft silty mud, oysters exceeding 120 mm in height were commonly tonged. A 190 mm height specimen from here was the largest oyster observed in all reconnaissance sampling.

Spat and small seed oysters were common in shell samples throughout East Bay (Table 6). Spat were more abundant than in Escambia Bay, and setting (as evidenced by spat ≤5 mm) extended well into December 1971. Larger seed oysters and small submarket oysters were also more abundant than in Escambia Bay.

Abundance of various oyster associates was greater in East Bay (Table 6) than in Escambia

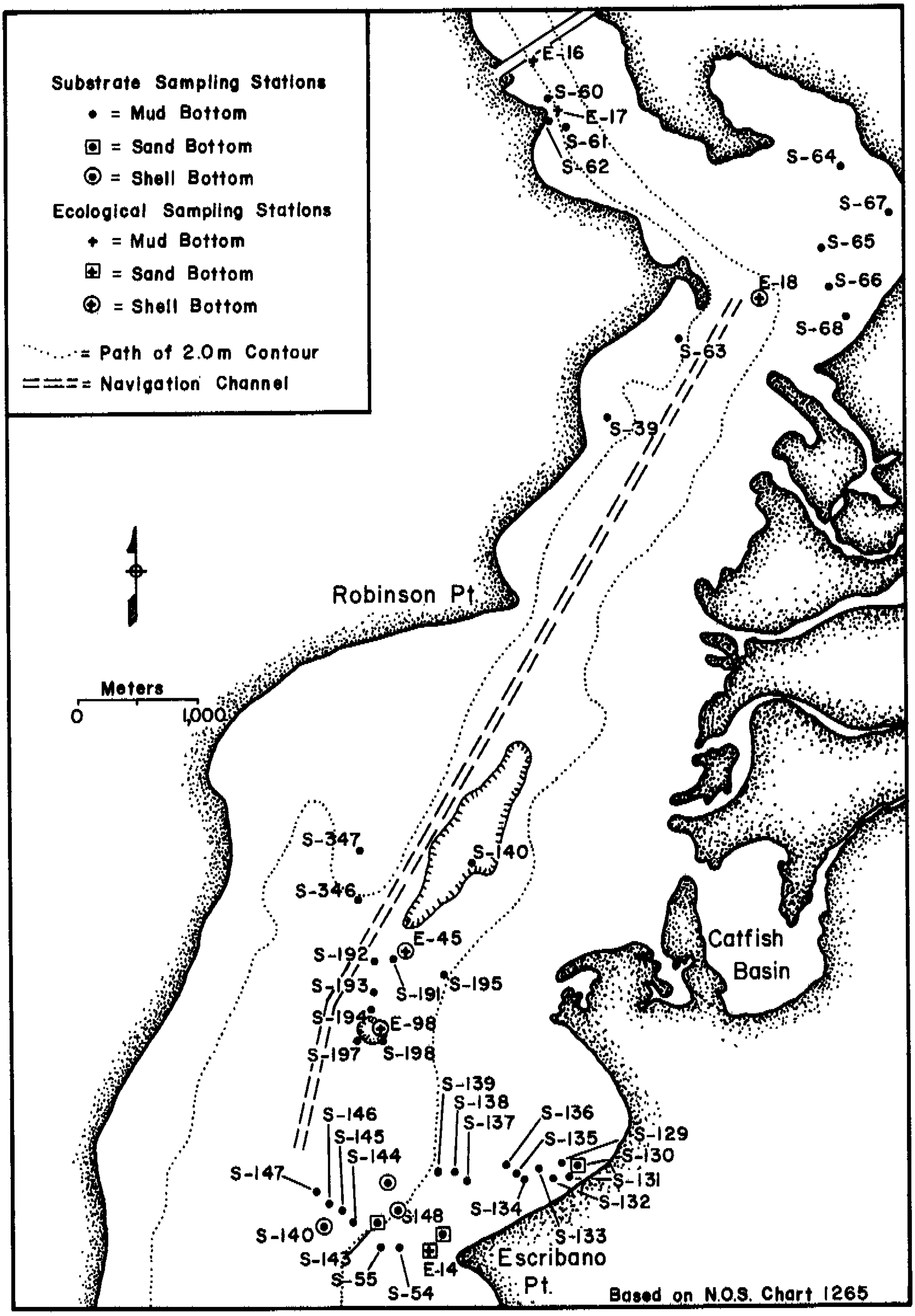

Figure 8. Reconnaissance survey stations, Blackwater Bay.

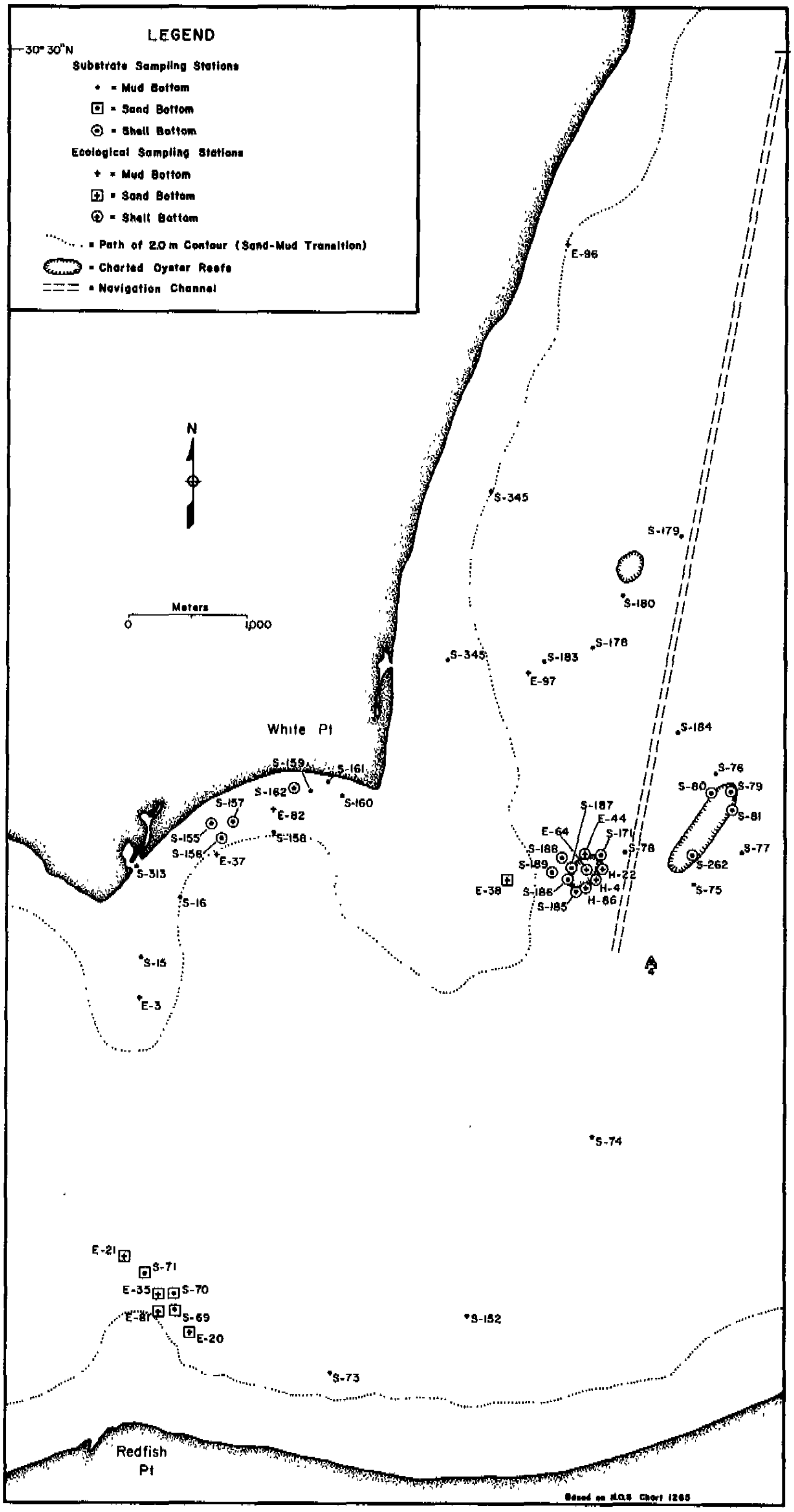

Figure 9. Reconnaissance survey stations, western portions of East Bay.

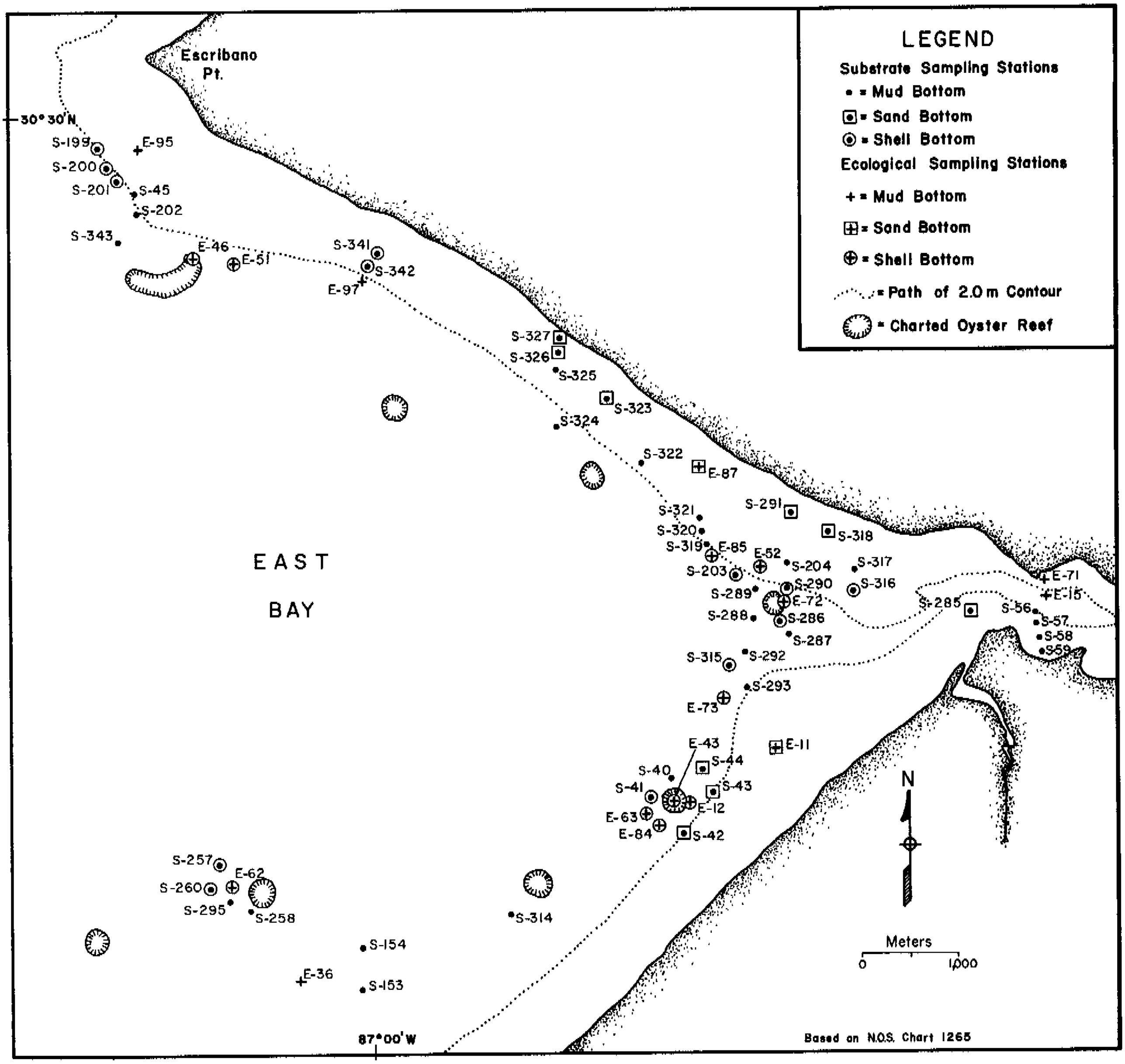

Figure 10. Reconnaissance survey stations, eastern portions of East Bay.

Bay, although foulers were seldom prevalent enough in either bay to be detrimental. *Crepidula*, *Cliona*, *Membranipora*, *Polydora*, and serpulids were often numerous. Unlike Escambia Bay, concentrations of mussel byssal threads and old barnacle shells were just as abundant as live mussels and barnacles. Encrustation by *Membranipora* at all stations was considerable, and by February 1972 many oysters, spat, and shells were almost completely covered. Densest encrustations were found on more southerly East Bay reefs.

A few oyster predators were sporadically encountered in East Bay. Several oyster drills approximately 30-60 mm in length, were tonged at stations E-4, E-72, and E-86. *Thais* egg capsules were found in January 972 at station E-72. *Eurypanopeus depressus* and other small xanthid crabs were usually numerous. Predatory flatworms, *Stylochus* sp., were occasionally noted at a few more southerly stations. Blue crabs and stone crabs, although not collected, were probably present.

As Brice (1898) and Prytherch (1933) noted,

TABLE 6. ECOLOGICAL DATA, EAST BAY
OCTOBER 1971 THROUGH FEBRUARY 1972 *

Station	E-4	E-12	E-36	E-37	E-43	E-44	E-46	E-51
Date	10/29	10/30	11/19	11/20	11/27	11/30	12/4	12/9
Depth (m)	2.5	2.5	3.3	2.1	3.0	3.1	2.3	2.4
% oysters in sample	50%	50%	10%	20%	20%	10%	50%	50%
Market oysters	O	C	NE	C	O	S	C	C
Sub-market oysters	O	C	NE	NE	O	S	C	O
Seed oysters	S	S	O	O	O	S	S	O
Spat	X	XX	XX	XX	XX	XXX	XX	XXX
Spat sizes range + $\bar{x}$	2-20mm $\bar{x}$ = 11	4-18mm $\bar{x}$ = 8	4-30mm $\bar{x}$ = 10	10-25mm $\bar{x}$ = 20	3-25mm $\bar{x}$ = 13	2-30mm $\bar{x}$ = 12	2-35mm $\bar{x}$ = 15	8-35mm $\bar{x}$ = 20
Barnacles	XX	XXX	X	XXX	XXX	XXX	X	X
Mussels	XX	XXX	X	XX	XXX	XX	XX	X
Crepidula Slipper shells	X	X	X	XX	XX	X	X	X
Bryozoa	X	X			XX	X	XX	X
Serpulid tubes	XX	X	XX		X	X	X	X
Polydora borings	X	X			XX	XX	X	X
Cliona borings	X	X	XX		XX	XX	X	X
Station	**E-52**	**E-62**	**E-63**	**E-64**	**E-72**	**E-73**	**E-82**	**E-84**
Date	12/9	12/22	12/22	12/27	1/7	1/7	1/22	1/26
Depth (m)	2.1	2.1	2.4	2.7	2.1	2.3	2.1	2.4
% oysters in sample	40%	50%	10%	50%	20%	40%	10%	20%
Market oysters	O	C	S	S	O	O	S	S
Sub-market oysters	O	C	S	C	S	O	S	S
Seed oysters	S	S	S	NE	S	O	NE	S
Spat	X	XXX	XX	XXX	XX	XX		XX
Spat sizes range + $\bar{x}$	5-30mm $\bar{x}$ = 25mm	5-36mm $\bar{x}$ = 22mm	6-25mm $\bar{x}$ = 11mm	8-27mm $\bar{x}$ = 20mm	10-40mm $\bar{x}$ = 25mm	10-30mm $\bar{x}$ = 22 mm	none	9-25mm $\bar{x}$ = 24mm
Barnacles	XX	XX	XX	XX	X	XX	XX	XX
Mussles	X	XX	XX	X	XX	X	X	X
Crepidula Slipper shells	X	XXX		XX	XX	X	XX	XX
Bryozoa	X	XXX		XXX		XX	XXX	XXX
Serpulid tubes	X	X	X	X		X		X
Polydora borings	X	XX	X	X	X	X		X

* N ≥ oysters/min; C = 5-7 oysters/min; O = 2-4 oysters/min; S ≤ 1 oyster/min; NE = not evident. See Table 2 for spat and fouling organism abundance code.

TABLE 6. ECOLOGICAL DATA, EAST BAY
OCTOBER 1971 THROUGH FEBRUARY 1972* (Continued)

Station	E-52	E-62	E-63	E-64	E-72	E-73	E-82	E-84
Cliona borings		X		X	X	X	X	

Station	E-85	E-86	E-94
Date	1/26	1/27	2/14
Depth (m)	2.4	2.5	1.9
% oysters in sample	20%	10%	40%
Market oysters	S	S	C
Sub-market oysters	S	S	C
Seed oysters	S	NE	S
Spat	X	XX	X
Spat sizes range + $\bar{x}$	11-35mm $\bar{x}$ = 30mm	3-21mm $\bar{x}$ = 15mm	5-35mm $\bar{x}$ =20mm
Barnacles	X	XX	XX
Mussels	XX	X	X
Crepidula Slipper shells	X	X	XX
Bryozoa		XXX	
Serpulid tubes	X	X	
Polydora borings	X	X	X
Cliona borings	X	X	

* N $\geq$ 8 oysters/min; C = 5-7 oysters/min; O = 2-4 oysters/min; S $\leq$ 1 oyster/min; NE = not evident. See Table 2 for spat and fouling organism abundance code.

East Bay has some potentially good oyster growing areas. Utilization of central and southern portions, however, is inadvisable due to intrusion of excessively saline bottom waters. More suitable salinity regimes occur along northeastern and northwestern shores.

BAYOU TEXAR

Bayou Texar (Figure 11) is closed to shellfish harvesting, but its potential as a prime source of relay oysters was surveyed. Bottoms are sandy south of the Cervantes Street bridge, and are chiefly soft mud to the north (NOS Chart, 1265).

Hydrography (Table 3) was similar to that noted in western Escambia Bay. Considerable tidal exchange created strong (approximately 3.0 kn) currents near the narrow mouth. Subtidal and intertidal oyster reefs were extensive near the Louisville and Nashville Railroad trestle and near the Cervantes Street bridge. Seed and submarket oysters were usually abundant; market oysters were less common. Recent boxes (summer and autumn 1971) were often plentiful. Thin, smooth valves and large marginal shell increments on living oysters indicated rapid growth.

Spat and small seed oysters were common throughout southern portions of the Bayou, and were especially numerous (2-4 per box) near the trestle; small, recent spat from late autumn spawnings were occasionally evident.

A few oysters occurred north of the Cervantes Street bridge. Scattered clusters grew approximately 10 m from shore on the slope of the sand-mud transition zone (depth 2.0-2.5 m). Market oysters were occasionally common; seed and submarket oysters were usually scarce. Most shells were discolored by thick films of silt.

Although fouling organisms were generally scarce thoughout the bayou, moderate numbers of barnacles (less than 10 per oyster) were found on subtidal oysters. In southern portions of the bayou, shells were seriously pitted by boring sponge.

It would have been impractical to relay oysters from northern portions of Bayou Texar due to their scarcity and to the low clearance of the Cervantes Street bridge. Although spat and seed oysters were abundant enough for relay in southern portions of the bayou, strong currents caused dredging difficulty there.

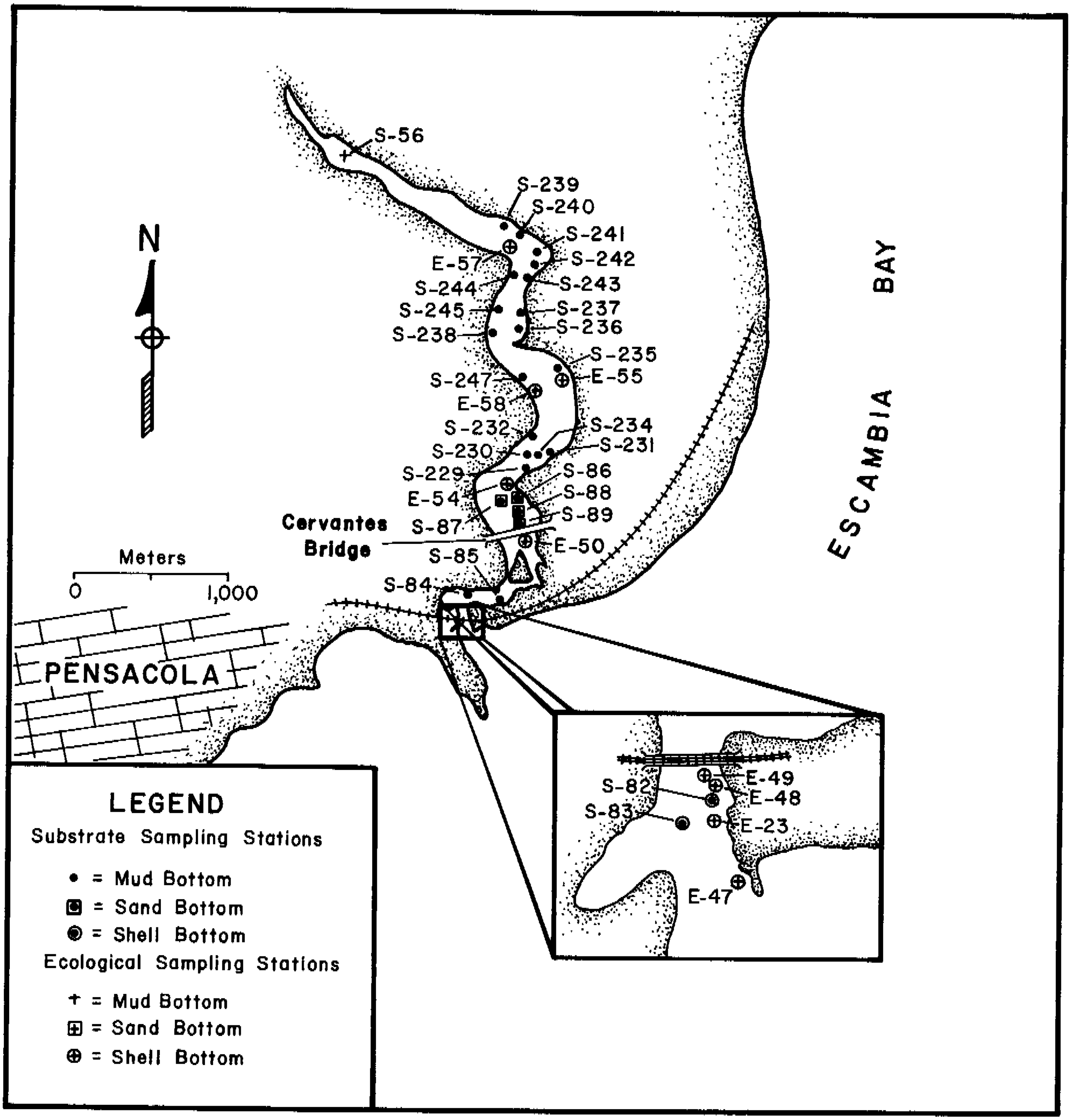

Figure 11. Reconnaissance survey stations, Bayou Texar.

SANTA ROSA SOUND

Santa Rosa Sound (Figure 12) was briefly surveyed for comparative ecological data on oysters living at higher salinities. Extensive spatfalls here (Butler, 1955) suggested this area would be a potential source of seed oysters. Since eastern and western extremities of this coastal lagoon receive sewage, only central portions are open to shellfishing (Florida State Board of Health, 1969b).

Limited hydrographic sampling (Table 3) indicated a homogenous salinity structure; bottom salinities ($\bar{x}$ = 23.8 ‰) were almost identical to surface values. Comparable hydrology was noted by Gallagher (1971), and Florida State Board of Health (1969b). Cooley (in press) characterized the area as a high salinity estuary (usually above 20.0 ‰ salinity).

Santa Rosa Sound oysters grew chiefly in scattered clusters amid *Thalassia testudinum* seagrass beds southeast and southwest of channel marker 129. Large subtidal shell reefs were not evident; high predation and rapid destruction of shell by boring sponge and other foulers probably prevent such development. Market oysters were scarce, usually comprising no more than 20% of each shell cluster. High summer 1971 mortalities were evidenced by three bushels of shell, dredged from one station, containing no live market or submarket oysters. Survival was better on oysters sheltered by *Thalassia* than on shell from adjacent open bottoms. Rapid growth was indicated by thin, smooth shells. Meats were not large or fat. Spat were exceptionally numerous (8-10 spat per shell) on shell clusters. While spat and seed oysters of all sizes were common, 5-10 mm spat and 25-30 mm seed were particularly evident. Casual observations revealed oyster drills, blue crabs, stone crabs, and other predators to be common, although few were collected during formal sampling.

Fouling organisms were more abundant in Santa Rosa Sound than in other areas surveyed. Boring sponges created such severe pitting that many shells crumbled under minimal handling. Small mussels were so numerous that dense mats of them covered 40% of some shells. Barnacles (usually 10-15 per oyster) were almost as numerous. Slipper shells were abundant, up to 40 were found on some boxes and 10-20 usually clustered on live oysters. *Membranipora* was uncommon, but colonies of *Bugula* sp., another bryozoan, were found on most shells. *Ostrea equestris* was also commonly collected.

Oyster rehabilitation in Santa Rosa Sound would probably not be successful due to high predation and fouling. It might be practical, however, to plant cultch in autumn and later transplant spatted shell or seed to less saline bottoms in East and Escambia Bays.

REHABILITATION PROGRAMS

The reconniassance survey showed hydrography of East and Escambia Bays to be generally within limits suitable for oyster rehabilitation (c.f. Butler, 1954b). However, conditions do occasionally become unfit for oyster production. Low salinities (below 5 ‰ undoubtedly occur during high river discharge and, if prolonged, can cause oyster mortalities (Brice, 1898; Prytherch, 1933) or reduced spawning (Butler, 1949; May, 1972). Conversely, prolonged salinities above 25 ‰ foster increased predation and disease (Quick and Mackin, 1971). May and Bland (1969) found that *Thais* killed over 85% of oyster spat in high salinity portions of Mobile Bay, comparable to some areas of East and Escambia Bays. Oysters require less oxygen than do finfish and, like most bivalves, utilize only about 10% of the available D.O. (Galtsoff, 1964). It appears, then, that oysters could probably survive in areas occasionally deficient in oxygen, but May (1973) noted oxygen deficiency related spatfall failures and oyster mortalities in Mobile Bay. Dissolved oxygen levels were acceptable ($\geq$ 4.0 ppm) during our study period, but lower concentrations probably occur during summer. However, we found no evidence of oyster mortalities from oxygen depletion.

Despite the September 1971 epizootic, selected areas of Escambia and East Bays exhibited potential for renewed oyster productivity. Spatfall of autumn 1971 was the best since those of the mid 1960's, and oyster foulers and predators were not sufficiently abundant to inhibit oyster rehabilitation. Selection of sites to effect such rehabilitation, however, was intricate, since many factors had to be considered. Much of the bay system was floored by soft, silty mud that could cause subsidence or burial of cultch and attached oysters. Similar effects could also result from severe sedimentation prevalent in many areas; this was so appreciable that oysters killed in the epizootic were often filled with sediment within three months. Accordingly, few localities possessed sufficient appropriate bottom type (firm, muddy sand) to be conducive to cultch planting. Prospective rehabilitation sites also had to be at least 2.5 m deep and clear of high oyster reefs or other navigational ob-

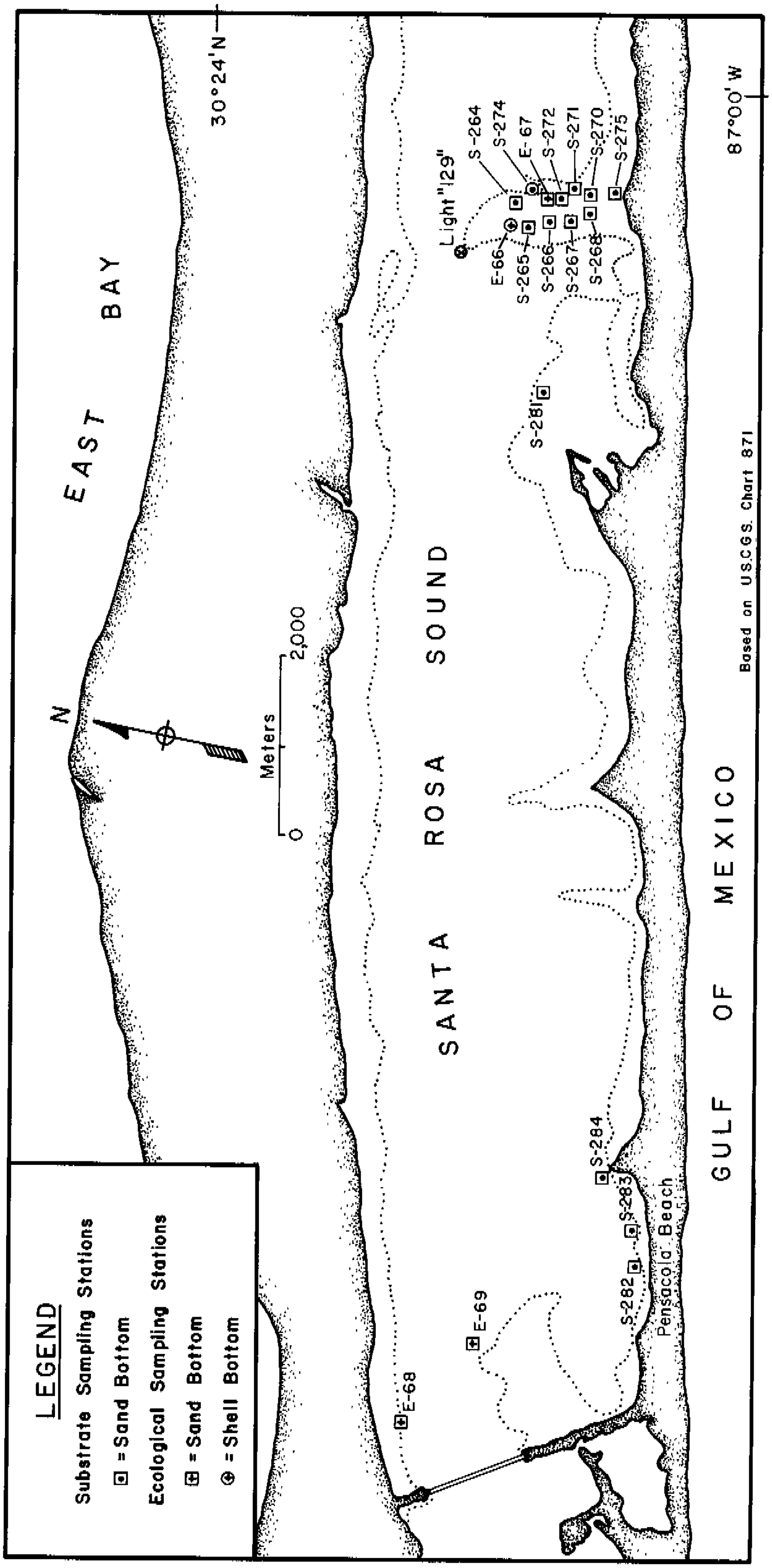

Figure 12. Reconnaissance survey stations, Santa Rosa Sound.

stacles in order to allow access to shell planting barges. Furthermore, much of Escambia Bay was contaminated by fecal coliform bacteria and unfit for shellfish propagation. Even when areas were otherwise suitable, adverse hydrographic or ecological conditions prevented utilization as oyster rehabilitation sites. For example, rehabilitation was inadvisable in southern East Bay because of high salinities and greater abundance of oyster predators and foulers.

HYDROGRAPHIC REGIME

Temperatures and salinities were usually taken during bimonthly visits to site C in Escambia Bay (depth 2.8 m) and site D in East Bay (depth 2.7 m). These limited data, when combined with occasional observations taken at other rehabilitation sites (Table 7), probably reflect prevailing conditions.

During March 1972 through June 1973, salinities at site C displayed typical estuarine fluctuations (Figure 13). When Escambia River discharge and Pensacola rainfall were below normal during summer and early autumn 1972, surface and bottom salinities were elevated at all Escambia Bay rehabilitation sites. By April 1973, however, when rainfall and river flows were greatest, Escambia Bay salinities lowered drastically until the bay was almost entirely fresh water. Extensive salinity sampling by E.P.A. (Lawrence Olinger, personal communication) additionally confirmed that during the second week of the extensive April flooding, a tongue of 2.0 ‰ river water extended from the mouth of Pensacola Pass as far as one mile into the Gulf of Mexico. Under normal conditions, however, saline bottom waters usually extend northward along the eastern shore of Escambia Bay and often exceed the range conducive to good oyster production.

Salinites at site D (Figure 14) were greatly influenced by fluctuations in Blackwater River discharge flowing southward along the western shore of East Bay. Stratification was usually appreciable, saline bottom water being covered by a layer of brackish water. Highly saline bottom waters were also noticeable along the northeastern shore of East Bay at site E, but vertical stratification was not so pronounced, probably because most river water is directed to the western shore. Although salinities at both East Bay sites were lowered during the spring 1973 flooding, the reduction was slight and of short duration when compared with that in Escambia Bay.

Seasonal temperature patterns at sites C and D were similar, and bottom values were usually with-

TABLE 7. MISCELLANEOUS TEMPERATURE AND SALINITY OBSERVATIONS, SITES A AND B (ESCAMBIA BAY) AND SITE E (EAST BAY)

Date	Salinity (‰)						Temperature (°C)					
	Surface			Bottom			Surface			Bottom		
	Site			Site			Site			Site		
	A	B	E	A	B	E	A	B	E	A	B	E
7-21-72		30.0			30.0			29.5			29.0	
7-22-72			29.0			30.0			30.8			29.5
8-26-72			25.0			28.0			32.0			32.3
9-13-72	24.0			28.0			31.2			30.5		
10-12-72			28.0			30.0			24.6			24.3
10-30-72			18.0						22.0			
12- 9-72		25.0			25.0			17.5			17.5	
2-20-73	10.0	6.0	10.0	15.0	15.0	22.0	12.3	12.6	11.2	11.0	10.2	12.0
3-15-73	4.0	4.0		4.0	4.0		22.2	21.8		22.0	21.8	
3-27-73			8.0			12.0			17.2			17.2
4-11-73			3.0			5.0			15.7			16.2
4-23-73	0.0	0.0		1.0	2.0		23.2	22.4		22.5	22.3	
5-29-73			6.0			10.0			28.0			26.0
6-27-73			8.0			10.0			31.2			30.5
Mean	9.5	13.0	15.0	12.0	15.2	18.3	22.2	20.7	23.6	21.5	20.1	23.5

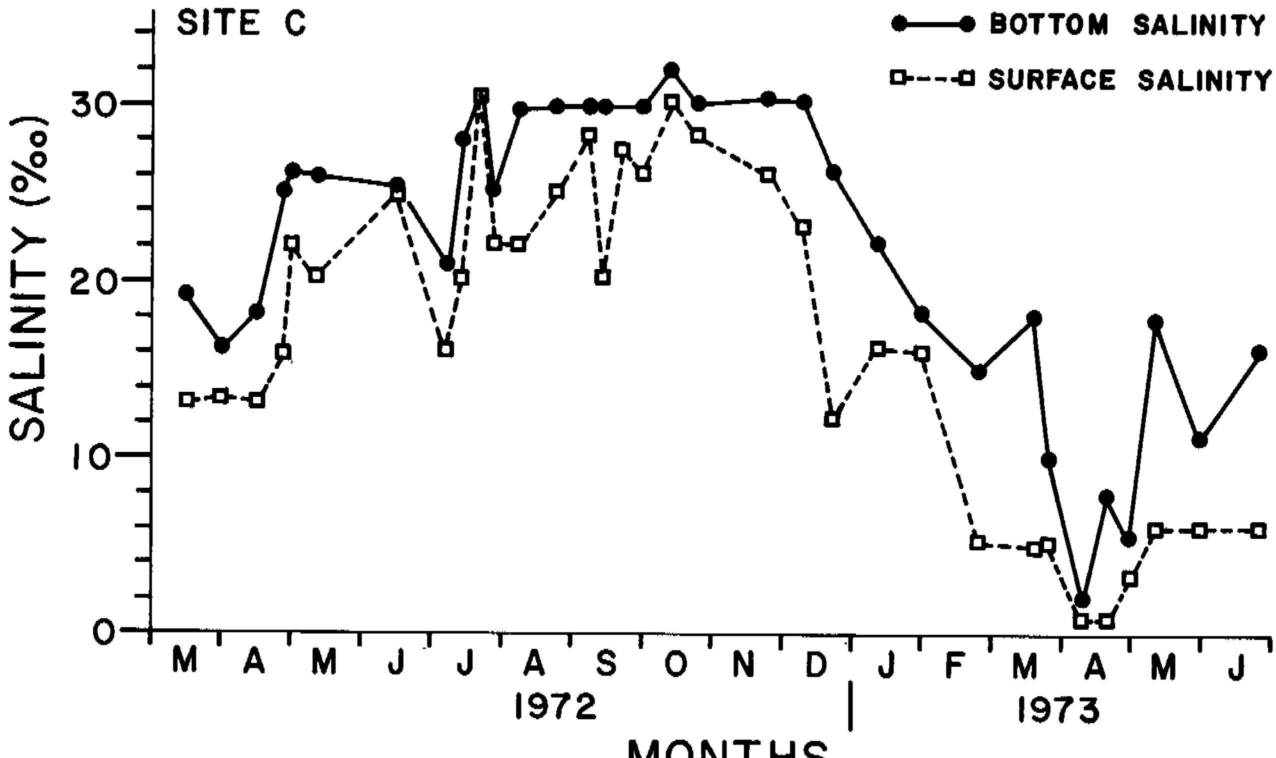

Figure 13. Surface and bottom salinities, Site C, Escambia Bay.

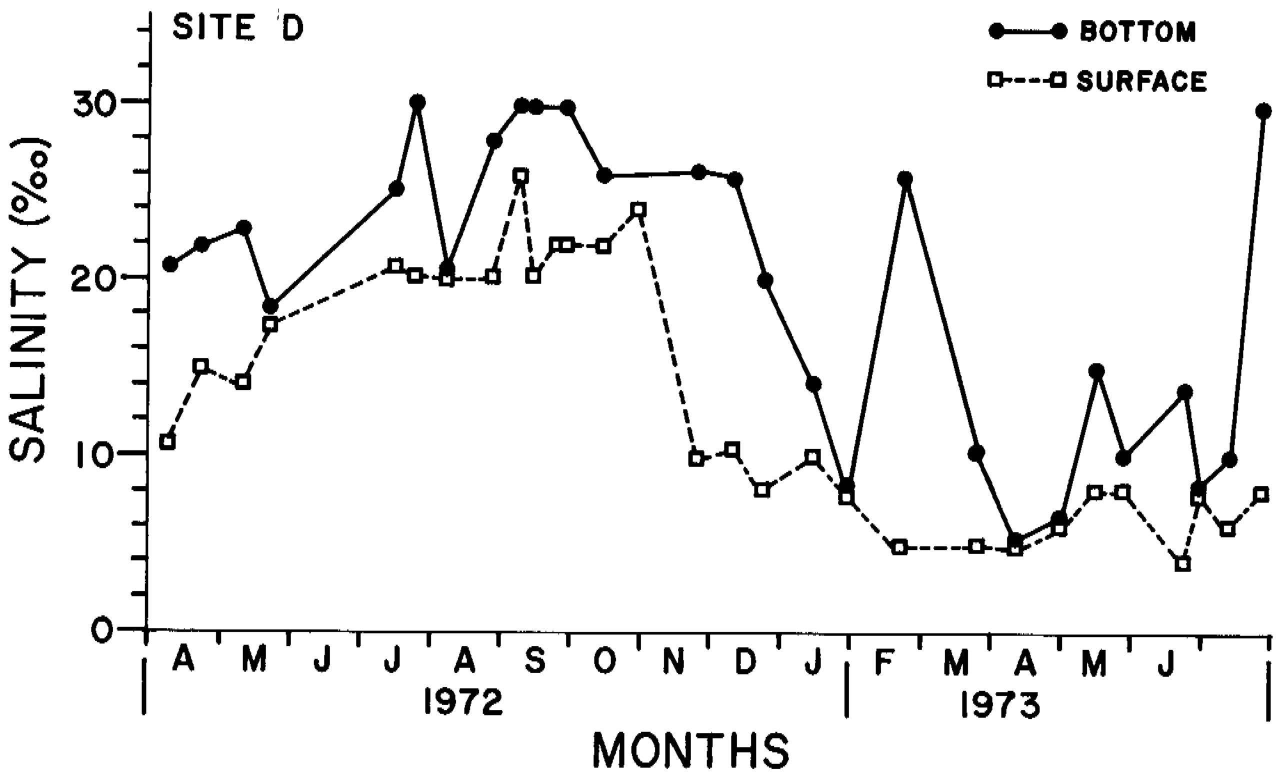

Figure 14. Surface and bottom salinities, Site D, East Bay.

in 2.0°C of surface values (Table 8). High temperatures noted in summer could unfavorably affect oysters by reducing oxygen content of bay waters or by abetting proliferation of *Labyrinthomyxa* fungal parasites (Quick and Mackin, 1971). Low winter temperatures were not severe enough to induce oyster hibernation, and were probably beneficial in promoting growth and decreasing predation, disease, and respiration.

OYSTER RELAY PROGRAM RESULTS

An estimated 5,725 bushels of market oysters, seed oysters, and spatted shell were transplanted to the three Escambia Bay rehabilitation sites (Table 9) between May and June 1972. Scarcity of oysters due to the 1971 kill, high cost of operating dredging vessels, and periods of unfavorable weather combined to prevent greater fulfillment of

TABLE 8. SURFACE AND BOTTOM TEMPERATURES, SITE C (ESCAMBIA BAY) AND SITE D (EAST BAY)

	Site C			Site D	
	Temperature (°C)			Temperature (°C)	
Date	Surface	Bottom	Date	Surface	Bottom
4-10-72	20.0	19.8	4-11-72	22.0	21.6
4-20-72	26.0	24.0	4-20-72	25.8	24.0
4-30-72	23.5	22.0	5- 9-72	27.2	24.0
5- 9-73	26.0	23.7	5-23-72	24.5	24.8
6-14-72	28.0	28.0	7-13-72	28.0	28.6
7- 5-73	30.0	30.0	7-21-72	29.6	29.4
7-13-72	27.2	28.6	8- 5-72	32.2	32.5
7-21-72	29.5	29.0	8-26-72	31.8	32.0
7-27-73	30.8	30.7	9- 5-72	31.5	31.2
8- 5-72	31.6	31.0	9-13-72	29.0	29.0
8-24-72	31.5	31.0	9-22-72	30.5	
9- 5-72	31.5	31.5	9-29-72	30.6	30.0
9-13-72	29.0	29.0	10-13-72	26.0	
9-29-72	30.5	29.5	10-30-72	22.0	
10-13-72	26.0	25.4	11-27-72	14.2	13.0
10-25-72	21.5	21.5	12- 9-72	19.2	16.4
11-27-72	13.5	13.5	12-20-72	15.0	12.0
12- 9-72	18.0	16.5	1-13-73	7.5	7.5
12-20-72	15.2	14.5	1-31-73	11.0	11.3
1-13-73	10.0	8.2	2-20-73	11.0	12.0
1-31-73	12.5	13.0	3-27-73	17.6	16.0
2-20-73	11.0	10.0	4-11-72	15.5	14.5
3-14-73	21.5	19.5	5-15-73	23.2	23.2
3-27-73	18.0	17.2	6-20-73	31.2	29.0
4-11-73	14.5	14.9	6-27-73	30.1	29.2
4-30-73	21.2	21.5	7- 6-73	31.6	30.0
5-15-73	22.3	23.0			
5-29-73	27.0	25.5			
6-20-73	29.0	28.5			
7- 6-73	31.3	31.0			

TABLE 9. PENSACOLA OYSTER RELAY OPERATIONS

Date	Code #	Vessel	Quantity (bu)	Source	Planting Site
5-15-72	# 1	*Fair Tide*	324	Gaberonne Pt. reefs	Site C on shell mounds
5-15-72	# 2	*Mary Alice*	120	Bayou Texar trestle	Site C on shell mounds
5-16-72	# 3	*Fair Tide*	425	Gaberonne Pt. reefs	Site C on shell mounds
5-16-72	# 4	*Mary Alice*	170	Bayou Texar trestle	Site C on shell mounds
5-17-72	# 5	*Fair Tide*	676	Gaberonne Pt. reefs	Site C on shell mounds
5-18-72	# 6	*Fair Tide*	425	Gaberonne Pt. reefs	Site C on shell mounds
5-18-72	# 7	*Mary Alice*	120	Bayou Texar trestle	Site C on shell mounds
5-19-72	# 8	*Fair Tide*	382	Gaberonne Pt. reefs	Site C on shell mound and on inshore
5-20-72	# 9	*Fair Tide*	427	Gaberonne Pt. reefs	Site C on firm mud inshore
5-22-72	#10	*Fair Tide*	512	Gaberonne Pt. reefs	Site C on firm mud inshore
5-23-72	#11	*Fair Tide*	145	Gaberonne Pt. reefs	Site C on firm mud inshore
5-27-72	#12	*Fair Tide*	322	Gaberonne Pt. reefs	Site C on firm mud inshore
5-30-72	#13	*Fair Tide*	232	Gaberonne Pt. reefs	Site C on firm mud inshore
5-31-72	#14	*Fair Tide*	299	Gaberonne Pt. reefs	Site C on firm mud inshore
6-03-72	#15	*Fair Tide*	271	Gaberonne Pt. reefs	Site C on firm mud inshore
6-05-72	#16	*Fair Tide*	27	Gaberonne Pt. reefs	Site A on shell mounds
6-06-72	#17	*Fair Tide*	260	Gaberonne Pt. reefs	Site B on shell mounds
6-07-72	#18	*Sea Farmer*	152.5	Bayou Texar	Site B on shell mounds
6-08-72	#19	*Sea Farmer*	202.5	Bayou Texar	Site B on shell mounds
6-27-72	#20	*Sea Farmer*	234.0	Bayou Texar	Site C on shell mounds
TOTAL 5,725 bushels					

this program.

During summer 1972, mortalities of relayed oysters were high; fresh boxes of market and seed oysters were invariably common. Deaths probably stemmed from shell damage during relaying as well as from characteristically high attrition suffered by market oysters during periods of elevated summer salinity and temperature. Some oysters were killed by *Thais* oyster drills unavoidably transplanted during relaying operations, and others were smothered (c.f. Gunter and McGraw, 1974) when scattered on the bottom.

Despite summer mortality of approximately 50% of transplanted market oysters, samples tonged during September still yielded an average of 10-20% harvestable oysters. Harvesting was encouraged by publicizing planting sites in the regional newspaper, *Pensacola News Journal*, September 2, 1972. Daily yields of approximately four to six bushels of relayed oysters per man were reported by several tongers active in Escambia Bay during September and October 1972. After October, tongers abandoned plantings, instead harvesting year-old market oysters that had begun to proliferate on natural reefs. Although relayed oysters were depleted by summer mortalities and autumn harvesting, considerable numbers of spat and seed oysters remained, and continued moderate future production was expected.

RESULTS OF SHELL PLANTINGS AND CULTCH EXAMINATIONS

Rehabilitation sites were planted with an estimated 26,600 m^3 (34,530 yd^3) of shell producing 452 shell piles (Table 10). Shell planting was temporarily suspended during the summer 1972 when spatfall was inexplicably light, and during periods when no appreciable spatfall could be expected (November 1972 through February 1973). Shell delivery delays prevented adherence to a rigid planting schedule.

No cultch plantings were made on existing natural reefs because such plantings would probably smother moderate numbers of seed oysters

TABLE 10. SUMMARY OF PENSACOLA SHELL CULTCH PLANTINGS

Date	Shell Type	Site	Planting # and Approximate Volume*
4- 7-72	oyster mudshell	C	C-1, @ 150 yd^3 in a pile C-2, @ 160 yd^3 in a pile C-3, @ 120 yd^3 in a pile C-4, @ 117 yd^3 in a pile C-5, @ 117 yd^3 in a pile
4- 7-72	oyster mudshell	D	D-1, @ 109 yd^3 in a pile D-2, @ 152 yd^3 in a pile D-3, @ 96 yd^3 in a pile D-4, @ 112 yd^3 in a pile
4- 7-72	oyster mudshell	E	E-1, @ 284 yd^3 in a pile E-2, @ 124 yd^3 in a pile E-3, @ 117 yd^3 in a pile E-4, @ 117 yd^3 in a pile
5-26-72	clam	A	A-1, @ 300 yd^3 in long mound with piles at ends
5-26-72	clam	B	B-1, @ 182 yd^3 in a long low mound B-2, @ 140 yd^3 in a long low mound B-3, @ 225 yd^3 in a long low mound B-4, @ 110 yd^3 in a long low mound
5-26-72	clam	C	C-6, @ 185 yd^3 in long low mound C-7, @ 70 yd^3 in long low mound C-8, @ 60 yd^3 in a pile C-9, @ 160 yd^3 in long low strip C-10, @ 120 yd^3 in long low strip C-11, @ 140 yd^3 in long low strip C-12, @ 113 yd^3 in long low strip C-13, @ 140 yd^3 in long low strip C-14, @ 100 yd^3 in long low strip C-15, @ 150 yd^3 in long low strip C-16, @ 120 yd^3 in long low strip
5-27-72	clam	C	C-17, @ 150 yd^3 in long low strip C-18, @ 120 yd^3 in long low strip C-19, @ 136 yd^3 in long low strip C-20, @ 70 yd^3 in a pile C-21, @ 90 yd^3 in a pile C-22, @ 86 yd^3 in a pile C-23, @ 110 yd^3 in a pile C-24, @ 80 yd^3 in a pile C-25, @ 75 yd^3 in a pile C-26, @ 84 yd^3 in a pile C-27, @ 90 yd^3 in a pile C-28, @ 70 yd^3 in a pile C-29, @ 85 yd^3 in a pile C-30, @ 93 yd^3 in a pile
5-29-72	clam	E	E-5 through E-31 planted to form conical piles of 80-100 yd^3 each
6-14-72	clam	C	C-31 through C-66 were planted to form conical piles, 70-90 yd^3 each
8- 9-72	shucked oyster	C	C-67 and C-68 planted as small conical piles of @ 4 yd^3 each
9-16-72	clam	D	D-5 through D-20 planted as conical piles 40-50 yd^3 each
10-30-72	clam	D	D-21 through D-39 planted to form conical piles, 50-60 yd^3 each
10-30-72	clam	E	E-32 through E-45 planted to form conical piles, 60-70 yd^3 each
3- 2-73	clam	E	E-46 through E-63 planted to form conical piles, 60-70 yd^3 each
5- 8-73	clam	D	D-40 through D-45 planted to form massive elongated mounds, 50-300 yd^3 due to bad weather
5-11-73	clam	D	D-46 through D-72 planted as 40-60 yd^3 low spreading mounds
6- 1-73	clam	C	C-69 through C-117 planted conical piles, 25-30 yd^3 each

TABLE 10. SUMMARY OF PENSACOLA SHELL CULTCH PLANTINGS (Continued).

Date	Shell Type	Site	Planting # and Approximate Volume*
6-11-73	clam	C	C-118 through C-168 planted as conical piles, 25-45 yd3 each
6-18-73	clam	C	C-169 through C-202 planted as conical piles, 25-45 yd^3 each
6-28-73	clam	C	C-203 through C-237 planted as conical piles, 25-40 yd^3 each
6-29-73	clam	C	C-238 through C-272 planted as conical piles, 25-40 yd^3 each
6-30-73	clam	D	D-73 through D-113 planted as conical piles, 25-45 yd^3 each.

* Locations depicted in Figure 1

set in autumn 1971, and because most natural reefs had past histories of erratic production. Furthermore, natural reefs were often located in central portions of silty basins where summer water circulation and quality would be expected to be poorest (FWPCA 1970; May, 1973). Cultch dispersed on such reefs would also be washed into surrounding silty areas by strong winter waves and currents.

Productivity of various shell plantings was evaluated in terms of average number of spat or seed oysters per shell, percent mortality (box count method), and growth. The net yield of a planting, however, also depends on the extent to which mortalities are offset by gains in size and market value of surviving oysters (Hopkins, 1950). Even when spatfall is good (as noted in Santa Rosa Sound) production may be low due to extremely high oyster mortality. Conversely, even where predation and disease may be low (as in northern Escambia Bay) production may be reduced because of limited spatfall and/or growth (Butler, 1954b). As indicated by Brice (1898), and Prytherch (1933) and our survey, neither spatfall nor mortality are excessive in East and Escambia Bays, hence at least moderate oyster production should be possible.

Presence of 1-2 larger spat (5-20 mm) or seed oysters per cultch clam shell or 2-4 larger spat or seed oysters per cultch oyster shell reflect optimum spatfall conditions in average to good Gulf coast oyster producing areas (Ingle and Dawson, 1953; St. Amant, 1958; Pollard, 1973). Lower spat abundance may, of course, limit oyster numbers and subsequent production. Greater spat abundance (such as in Santa Rosa Sound) does not necessarily reflect optimum oyster recruitment conditions, since stunted, misshappen, or poor quality oysters may result (Butler, 1954b; Hopkins, 1955). Because our data showed that Escambia and East Bay rehabilitation sites possessed at least average suitability for oyster growth and survival, our spat per shell criteria appear applicable for assessing recruitment intensity.

Field examinations of 2,000-4,000 clam shells, periodically taken from each of several selected mounds, provided general information on spatfall. Subsamples were given closer inspection in the laboratory to check field observations. During May through August 1972, setting was light and examination of several hundred shells from each sample was required to find evidence of spatfall. By September, however, setting increased and indications of spatfall intensity at representative mounds could be obtained from examination of only 25 clam shells or only 10 oyster shells. By spring 1973, many plantings were approximately one year old; thereafter, larger numbers of shells were occasionally inspected for more accurate productivity assessment.

Central Escambia Bay Rehabilitation Sites

Site A (depth 2.4 m) was situated on firm, sandy mud approximately 200 m off the northeastern shore of Escambia Bay. Despite survey evidence of possible unfavorable hydrography, poor oyster productivity, and extensive sedimentation, 230 m^3 (300 yd^3) of clam shell were planted on May 26, 1973, forming two mounds, each approximately 10.0 m long and 1.5 m high. These experimental plantings were intended to provide comparison of oyster productivity in north — central, eutrophic portions of eastern Escambia Bay and that in more southerly, less degraded portions.

Cultch examinations in following months (Table 11) showed productivity was extremely poor; average number of spat per shell was 0.06. Approximately 1 year after planting, a tonged sample of 1,000 exposed shells yielded only 15 spat and seed oysters from 8.0 to 49.0 mm in height ($\bar{x}$ = 30.4 mm); these, like previous samples, indicated spatfall occurred in early summer 1972. Setting in autumn 1972, 1973, and 1974 was negligible when compared with spatfall at other rehabilitation sites. Mortality was evidently low.

Species composition of oyster associates at Site A was lower than at other sites, but abundances were often high enough to inhibit spat settlement.

Most cultch shells were encrusted by *Membranipora*; almost 25% in some samples were completely covered. During summer 1972, serpulid worms became profuse, although most died the following winter. Barnacles were invariably most common foulers. *Crepidula* and *Ischadium* were scarcer than at more saline sites; neither boring sponge nor oyster predators were encountered.

Sedimentation of shell was more extensive than at other sites and was probably a major factor in preventing good spat sets. Silt films 1-2 mm thick were found on most shells within three months after planting. Because summer 1972 Escambia River flows were too low to carry much silt, it is likely that observed films originated largely from resuspension of benthic sediments by wave action.

Site B (depth 2.6 m) was situated approximately 300 m off the eastern shore of Escambia Bay in an area of scattered oyster clusters and firm mud bottoms. Four clam shell mounds, 10.0 m long and 1.0-1.5 m high, were planted on May 26, 1972.

Subsequent sampling showed that spat and seed oysters were usually scarce (Table 12). Only 49 spat and seed oysters were found ($\bar{x}$ = 0.1 spat per shell) in a sample of 500 shells tonged approximately 1 year after planting. In September 1972, 150 clam shells yielded 12 spat and indicated spatfall was light at Site B in comparison with other sites. Although most spat and seed were between 15-25 mm high by May 1973, some larger seed oysters from summer 1972 sets were also evident. Boxes were uncommon in all samples.

Cultch fouling was generally light to moderate and did not appear to be a factor in preventing spat settlement. Serpulid worm tubes were usually numerous, especially during summer. *Membranipora* encrustations and barnacles were less common. *Crepidula* and mussels were scarce, but boring sponge eroded many shells when salinities were high in 1972. Small xanthid crabs were the only evident predators.

Siltation of shell was considerable, but not as severe as noted at Site A. Similarly, it is likely that most silt accumulations developed from resuspension of bottom sediments.

Southern Escambia Bay Rehabilitation Site

Site C (Figure 15) in southeastern Escambia Bay received the major portion of rehabilitation effort because 1) contamination or debilitation of the oysters was unlikely, since sources of pollution were far removed; 2) more firm bottom was available for planting than at any other part of Escambia Bay; 3) fresh water influences from eutrophic northern Escambia Bay were slight; 4) salinity regime was within a range suitable for oyster culture; and 5) good oyster growing potential was indicated by numerous clusters of scattered oysters which suffered only moderate losses during the September 1971 kill.

Several types of cultch were used at Site C, and many plantings were made (Table 10). Resulting shell piles covered approximately 4.8 hectares (Figure 15). Initially, spatfall (indicated by spat $\leq$ 10 mm) was poor after spring and summer shell plantings, most occurring in autumns of 1972, 1973, and 1974 (Tables 13-17). Because our studies emphasized assessment of recruitment (spatfall), samples may not have been large enough to accurately determine productivity (abundance of seed and market oysters). Despite monthly inconsistencies in abundance estimates at each planting, progressive increases in size and numbers of larger (11-19 mm) and seed oysters were observed. Although productivity was low in 1972, additional plantings were made in 1973 because potential for at least moderate production was evident. Artificial reef production would have the additional benefit of diverting some fishing pressure from already depleted natural reefs.

Shucked oyster shells from Apalachicola caught spat better than other cultches tested (oyster mudshell and clam shell). Shucked shells were unavailable locally in quantity and only 100-150 m^3 were planted here for experimental comparison. St. Amant (1958) also noted shucked shell caught more spat than did mudshell. Greater productivity of shucked shell in our study may have been due to the greater surface area presented for spat setting; shucked shells were larger and packed more irregularly and loosely, leaving considerable interstitial space. Mudshell tends to pack down tightly, with shell fragments and debris filling interstitial spaces.

Siltation and abundance of oyster predators and foulers were generally too low to greatly limit productivity of plantings. Underwater inspection showed moderate to substantial siltation was confined mainly to shells at the lowermost periphery of each mound. Upper portions of mounds were probably kept relatively free of silt by wave action. Except for the ubiquitous xanthid crabs, oyster predators or their characteristic damage were only

TABLE 11. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 5/26/72 AT SITE A, JULY 1972 THROUGH MAY 1973; FEBRUARY AND SEPTEMBER 1974

Site: A, northeast shore of Escambia Bay

Material: *Rangia* clam shells planted 5/26/72 to form two low elongate parallel mounds

	1972		1973				1974	
Date sampled:	7/21	9/13	2/21	3/15	4/23	5/29	2/20	9/19
No. shells examined	800	100	25	25	25	1,000	25	25
No. shells with oysters	0	3	3	0	2	15	9	10
No. spat and seed oysters	0	4	3	0	2	15	9	11
$\bar{x}$ no. oysters per shell	0	.03	.12	0	.08	.01	.4	.4
$\bar{x}$ no. oysters per spatted shell	0	1.3	1.0	0	1.0	1.0	1.0	1.1
Oyster height range (mm)	0	2.5-11.5	42.0-50.0	0	25.0-32.0	8.0-49.0	8.0-37.0	1.0-27.0
$\bar{x}$ oyster height (mm)	0	8.3	46.6	0	28.5	30.4	18.6	21.9
% oysters 0.5-10.0 mm	0	50.0	0	0	0	7.0	44.0	9.0
% oysters 11-19 mm	0	50.0	0	0	0	26.0	11.0	9.0
% oysters 20-30 mm	0	0	0	0	50.0	13.0	22.0	81.0
% oysters 31-40 mm	0	0	0	0	50.0	13.0	22.0	0
% oysters > 40 mm	0	0	100.0	0	0	40.0	0	0

sporadically encountered. *Thais* drills and evidence of oyster destruction by either blue crabs or stone crabs were prominent only in September 1974. Shells from upper sides of these piles were seldom fouled, but those from lower portions were often lightly to moderately encrusted by barnacles, *Membranipora*, and serpulid worms. *Cliona* sponge pitted most shells from the base of each pile. *Ischadium* mussels and *Crepidula* snails were rare.

East Bay Rehabilitation Sites

Sites D (Figure 16) and E (Figure 17) were both planted with clam shells and mudshell (Table 10). Coverage of these sites was 1.7 hectares and 1.0 hectares, respectively. Seasonal distribution of spatfall was similar to that noted at Site C but intensity was usually greater (Tables 18-25). However, intense spatfall (spat ≤ 10 mm) noted on some occasions (such as autumn 1972) did not always produce an abundance of seed oysters. Since there was no corresponding high incidence of boxes of larger spat (11-19 mm) or seed oysters, most of this substantial spat loss must have occurred soon after setting and delicate boxes of newly set spat did not persist as mortality evidence. Despite considerable attrition of newly set spat, many survived and produced larger spat and seed oysters. Shell piles constructed in late October 1972 to assess effectiveness of plantings made after peak spatfall, were generally unproductive when compared to April and September 1972 plantings and spring 1973 plantings.

As in Escambia Bay, siltation was appreciable only on lowermost peripheries of shell piles and predators or predator-induced damage were seldom noted. Shells from East Bay sites bore larger populations of the same fouling organisms noted at Site C. These were still not abundant enough to be very detrimental.

ATTACHMENT OF OYSTERS AND FOULING ORGANISMS TO CEMENT BOARD TILES

Cement board tiles have been employed by Butler (1955), Shaw (1967), Finucane and Campbell (1968), Moore and Trent (1971), Hidu and Haskin (1971), Hoese et al. (1972), and Pollard (1973) for quantification of spat and fouler setting. Tile observations at Sites C and D complimented shell examinations, but broader application of the data is questionable. Tiles occupied only miniscule portions of the estuarine water column. In addition to expected seasonal and annual variations in setting, intensity of oyster and fouler attachment differs between points only a few hundred meters apart and also with tile orientation in the water column (Butler, 1955).

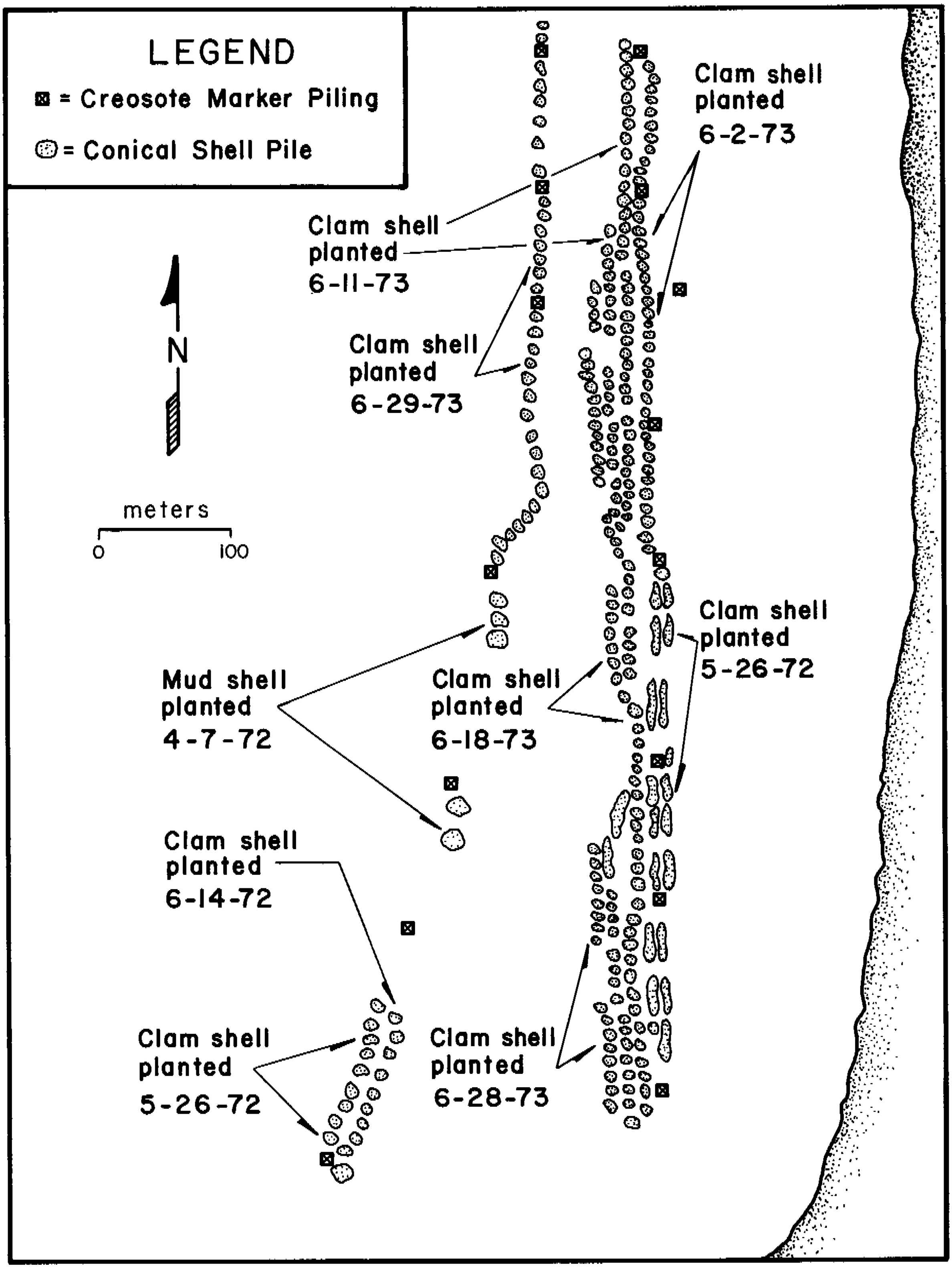

Figure 15. Position of shell plantings, Site C, Escambia Bay.

TABLE 12. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 5/26/72 AT SITE B, JULY 1972 THROUGH MAY 1973; FEBRUARY AND SEPTEMBER 1974

Site: B, off eastern shore of Escambia Bay

Material: *Rangia* clam shell

Date planted: 5/26/72

	1972								1973					1974	
Date sampled:	7/5	7/21	9/5	9/13	9/29	10/25	11/27	12/9	1/31	2/20	3/15	4/23	5/29	2/20	9/19
No. shells examined	800	900	50	50	50	25	25	25	25	25	25	25	500	25	25
No. shells with oysters	10	8	7	9	7	3	10	7	8	9	7	5	46	15	21
No. spat and seed oysters	10	8	7	9	7	3	12	7	8	9	7	6	49	19	32
$\bar{x}$ no. oysters per shell	.01	.01	.14	.18	.18	.12	.48	.28	.32	.36	.28	.24	.09	.76	1.20
$\bar{x}$ no. oysters per spatted shell	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0	1.2	1.1	1.6	1.5
Oyster height range (mm)	1.5-16.8	6.0-18.0	1.0-8.0	.5-22.5	2.0-18.0	3.0-16.0	3.5-17.0	7.0-25.0	6.5-24.0	9.0-30.0	4.0-34.0	7.0-19.0	7.0-35.0	5.0-52.0	2.0-35.0
$\bar{x}$ oyster height (mm)	7.9	11.2	5.1	9.1	12.0	8.0	11.6	16.0	14.4	20.8	20.8	15.3	19.2	19.4	18.1
% oysters .5-10 mm	80.0	25.0	100.0	66.0	43.0	66.6	33.3	42.0	50.0	12.0	29.0	16.0	6.0	36.8	18.7
% oysters 11-19 mm	20.0	75.0	0	11.0	57.0	33.3	58.6	16.0	13.0	44.0	0	83.0	42.0	15.7	34.4
% oysters 20-30 mm	0	0	0	22.0	0	0	8.0	42.0	37.0	44.0	42.0	0	42.0	26.3	25.0
% oysters 31-40 mm	0	0	0	0	0	0	0	0	0	0	29.0	0	9.0	5.2	18.7
% oysters > 40 mm	0	0	0	0	0	0	0	0	0	0	0	0	0	10.5	0

TABLE 13. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 4/7/72 AT SITE C, APRIL 1972 THROUGH JUNE 1973

Site: C, southeastern Escambia Bay

Material: Mobile Bay dredged oyster shells planted in five conical mounds

Date planted: 4/7/72

	1972									1973					
Date sampled:	4/20	6/16	7/21	8/5	9/29	10/13	11/27	12/9	12/20	1/31	2/20	3/15	4/11	5/29	6/27
No. shells examined	7	10	100	62	10	10	10	10	10	10	10	10	100	10	10
No. shells with oysters	1	4	13	12	9	7	7	8	9	2	8	9	50	5	5
No. spat and seed oysters	1	5	13	16	41	26	14	18	37	2	21	31	77	8	6
$\bar{x}$ no. oysters per shell	.14	.5	.13	.19	4.1	2.6	1.4	1.8	3.7	.2	2.1	3.1	.77	.8	.6
$\bar{x}$ no. oysters / spatted shell	1.0	1.8	1.0	1.3	4.5	3.7	2.0	2.2	4.1	1.0	2.6	3.4	1.5	1.6	1.0
Oyster height range (mm)	1.0	8.0-16.0	8.5-22.0	6.5-30.0	.3-32.0	.6-21.5	2.0-24.0	2.0-45.0	2.0-46.0	29.0-33.0	5.0-53.5	5.0-43.0	5.0-45.0	10.0-56.0	15.0-42.0
$\bar{x}$ oyster height (mm)	1.0	11.0	13.0	17.8	8.3	4.0	11.3	14.6	19.2	31.0	23.0	19.4	18.8	26.6	30.0
% oysters .5-10 mm	100.0	60.0	46.0	25.0	56.0	92.4	50.0	27.7	8.1	0	4.7	35.4	14.2	12.5	0
% oysters 11-19 mm	0	40.0	46.0	34.0	29.0	3.8	36.0	61.0	43.2	0	38.0	16.1	40.2	25.0	50.0
% oysters 20-30 mm	0	0	7.0	41.0	12.0	3.8	14.0	5.5	27.0	50.0	38.0	22.0	33.7	37.0	0
% oysters 31-40 mm	0	0	0	0	2.0	0	0	0	18.9	50.0	9.5	14.3	9.0	12.5	16.0
% oysters > 40 mm	0	0	0	0	0	0	0	5.5	.5	0	9.5	6.4	2.5	12.5	33.0

TABLE 14. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 5/26/72 AT SITE C, JUNE 1972 THROUGH NOVEMBER 1973; SEPTEMBER 1974

Site. C, southeastern Escambia Bay

Material: *Rangia* clam shells planted in conical piles

Date planted: 5/26/72

Date sampled:	1972									1973							1974		
	6/15	6/26	7/23	7/24	8/24	9/5	9/22	10/13	12/9	1/31	2/20	3/14	4/23	5/29	6/28	11/3	9/19 crest	9/19 base	9/19 base
No. shells examined	20	50	1,000	575	100	50	50	25	25	25	25	25	25	500	25	25	25	25	25
No. shells with oysters	0	0	6	13	13	12	17	10	13	9	12	18	18	52	15	25	24	20	25
No. spat and seed oysters	0	0	6	13	14	16	17	11	17	9	15	31	31	67	22	40	85	94	60
$\bar{x}$ no. oysters per shell	0	0	.01	.02	.14	.32	.34	.44	.68	.36	.60	1.2	1.2	.13	.87	1.6	3.4	3.7	2.4
$\bar{x}$ no. oysters/spatted shell	0	0	1.0	1.0	1.1	1.3	1.0	1.1	1.3	1.0	1.2	1.7	1.7	1.2	1.4	1.6	3.5	4.7	2.4
Oyster height range (mm)	0	0	10.2-23.0	3.0-26.0	1.0-21.5	.5-26.0	2.0-20.0	.6-9.5	4.0-28.0	4.0-22.0	5.0-55.0	5.0-37.0	5.0-37.0	6.0-35.0	12.5-41.0	1.0-35.0	1.0-36.0	1.0-42.0	1.0-55.0
$\bar{x}$ oyster height (mm)	0	0	16.1	13.0	10.5	8.9	10.5	3.5	11.1	13.6	22.2	18.6	18.9	20.2	27.6	11.2	11.2	26.8	24.0
% oysters .5-10 mm	0	0	0	30.7	42.8	68.7	52.9	100.0	52.9	33.3	26.6	29.0	19.3	10.7	0	60.0	56.2	23.3	40.8
% oysters 11-19 mm	0	0	66.6	61.5	35.7	12.5	41.1	0	35.2	33.3	26.6	25.8	29.0	53.7	14.2	27.5	32.9	1.0	6.6
% oysters 20-30 mm	0	0	33.3	7.6	21.0	18.7	5.8	0	11.7	33.3	26.6	25.8	38.7	31.3	50.0	5.0	7.3	38.4	11.6
% oysters 31-40 mm	0	0	0	0	0	0	0	0	0	0	6.6	19.3	12.9	4.4	27.0	7.5	2.4	15.3	25.0
% oysters > 40 mm	0	0	0	0	0	0	0	0	0	0	13.3	0	0	0	9.0	0	1.2	23.0	16.0

TABLE 15. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 6/14/72 AT SITE C, JUNE 1972 THROUGH NOVEMBER 1973; FEBRUARY AND SEPTEMBER 1974

Site: C, southeast Escambia Bay

Material: *Rangia* clam shells planted in conical piles

Date planted: 6/14/72

	1972											1973				1974	
Date sampled:	6/27	7/5	7/13	8/5	8/24	9/5	9/13	9/22	10/25	11/27	12/9	1/31	3/14	6/20	11/3	2/21	9/19
No. shells examined	50	400	500	1,983	100	50	100	50	25	25	25	25	25	500	13	25	15
No. shells with oysters	0	0	3	12	13	10	11	4	14	1	6	12	16	40	13	21	15
No. spat and seed oysters	0	0	3	12	13	13	11	4	15	1	8	12	23	45	42	51	71
$\bar{x}$ no. oysters per shell	0	0	.01	.01	.13	.2	.11	.8	.6	.04	.3	.5	.9	.09	3.2	2.0	4.3
$\bar{x}$ no. oysters spatted shell	0	0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.3	.5	1.4	1.1	3.2	2.4	4.3
Oyster height range (mm)	0	0	7.6-11.0	3.0-22.0	1.0-21.5	3.5-31.0	1.5-19.0	6.0-19.0	2.5-26.0	7.0	3.0 20.0	4.0-31.5	7.0-43.0	9.0-44.0	4.0-22.0	6.0-32.0	1.0-30.0
$\bar{x}$ oyster height (mm)	0	0	8.9	12.9	7.2	12.3	7.1	15.0	13.0	7.0	12.9	13.3	20.2	21.2	10.5	13.4	9.8
% oyster .5-10 mm	0	0	66.6	50.0	69.2	53.8	72.7	25.0	40.0	100.0	37.5	25.0	26.0	2.2	54.7	39.2	80.2
% oysters 11-19 mm	0	0	33.3	33.3	23.0	15.3	27.2	75.0	40.0	0	37.5	58.3	34.7	37.7	40.4	37.2	12.6
% oysters 20-30 mm	0	0	0	16.6	7.6	23.0	0	0	20.0	0	25.0	8.3	30.4	46.6	4.7	19.0	7.0
% oysters 31-40 mm	0	0	0	0	0	7.6	0	0	0	0	0	8.3	4.3	11.1	0	3.9	
% oysters > 40 mm	0	0	0	0	0	0	0	0	0	0	0	0	4.3	2.2	0	0	

TABLE 16. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 8/9/72 AT SITE C, AUGUST 1972 THROUGH JUNE 1973; SEPTEMBER 1974

Site: C, southeastern Escambia Bay

Material: Shucked Apalachicola oyster shells in a low conical mound

Date planted: 8/9/72

	1972						1973			1974	
Date sampled:	8/24	9/5	9/13	9/22	10/25	11/23	1/31	2/20	6/28	9/19a base	9/19b crest
No. shells examined	20	20	15	25	10	10	10	10	10	10	10
No. shells with oysters	3	20	14	13	5	9	9	10	5	9	10
No. spat and seed oysters	6	83	24	22	17	17	29	41	7	317	196
$\bar{x}$ no. oysters per shell	.03	4.6	1.6	.8	1.7	1.7	2.9	4.1	.7	31.7	19.6
$\bar{x}$ no. oysters per spatted shell	2.0	4.6	1.6	1.6	3.4	1.8	3.2	4.1	1.4	35.2	19.6
Oyster height range (mm)	1.0-6.0	.3-22.0	1.0-28.0	1.0-31.0	1.0-20.0	2.0-33.0	5.0-9.5	40.0-45.0	20.0-39.0	.5-40.0	.5-49.0
$\bar{x}$ oyster height	3.4	6.2	10.2	12.0	4.2	17.0	29.7	22.0	27.1	17.5*	9.0*
% oysters .5-10 mm	100.0	75.9	54.6	54.5	88.2	23.5	3.4	7.3	0	57.3	84.5
% oysters 11-19 mm	0	21.6	37.5	31.8	5.8	35.2	24.1	39.0	0	1.0	12.4
% oysters 20-30 mm	0	2.4	8.3	9.9	5.8	29.4	27.5	17.0	57.1	14.2	3.7
% oysters 31-40 mm	0	0	0	4.5	0	11.6	34.4	14.6	42.8	21.4	0
% oysters > 40 mm	0	0	0	0	0		10.0	21.9	0	7.1	3.7

* Spat < 2.0 mm height not included in computation

TABLE 17. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 6/2/73 AT SITE C, JUNE AND NOVEMBER 1973; FEBRUARY AND SEPTEMBER 1974

Site: C, southeastern Escambia Bay

Material: *Rangia* clam shells planted in conical piles

Date planted: 6/2/73

	1973		1974			
Date sampled:	6/20	11/3	2/20 crest	2/20 base	9/19 base	9/19 crest
No. shells examined	25	25	25	25	25	25
No. shells with oysters	0	25	16	22	23	23
No. spat and seed oysters	0	75	24	66	61	54
$\bar{x}$ no. oysters per shell	0	3.0	.9	2.6	2.4	2.1
$\bar{x}$ no. oysters/spatted shell	0	3.0	1.5	3.0	2.6	2.3
Oyster height range (mm)	0	3.0-27.0	7.0-20.0	5.0-27.0	.5-41.0	11.0-34.0
$\bar{x}$ oyster height (mm)	0	8.7	12.4	12.9	26.1*	15.8*
% oysters .5-10 mm	0	70.6	45.8	34.3	18.4	37.0
% oysters 11-19 mm	0	25.3	50.0	50.0	7.2	35.1
% oysters 20-30 mm	0	4.0	4.2	13.6	27.0	18.5
% oysters 31-40 mm	0	0	0	0	41.0	12.9
% oysters > 40 mm	0	0	0	0	5.5	0

* Spat < 2.0 mm not included in computation

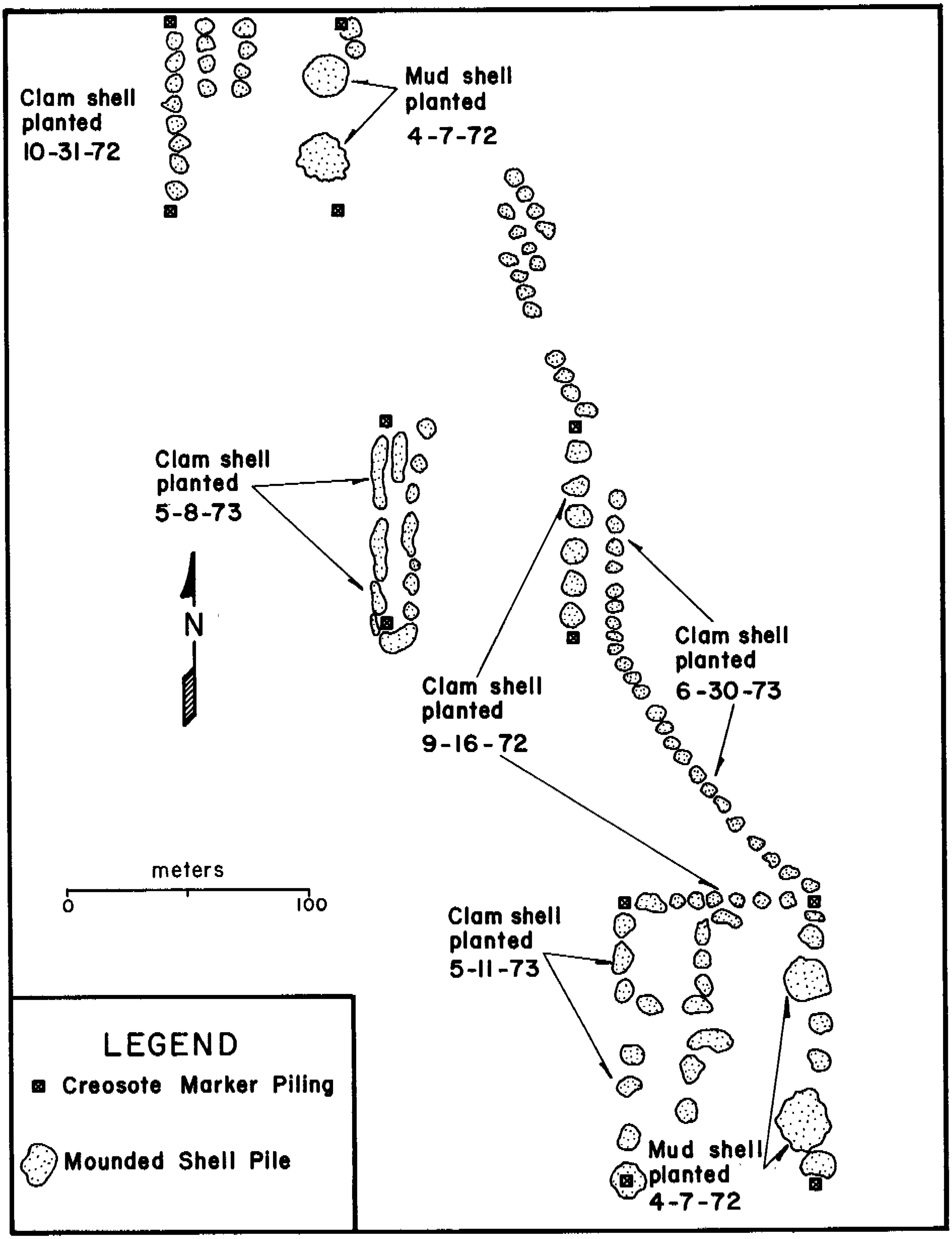

Figure 16. Position of shell plantings, Site D, East Bay.

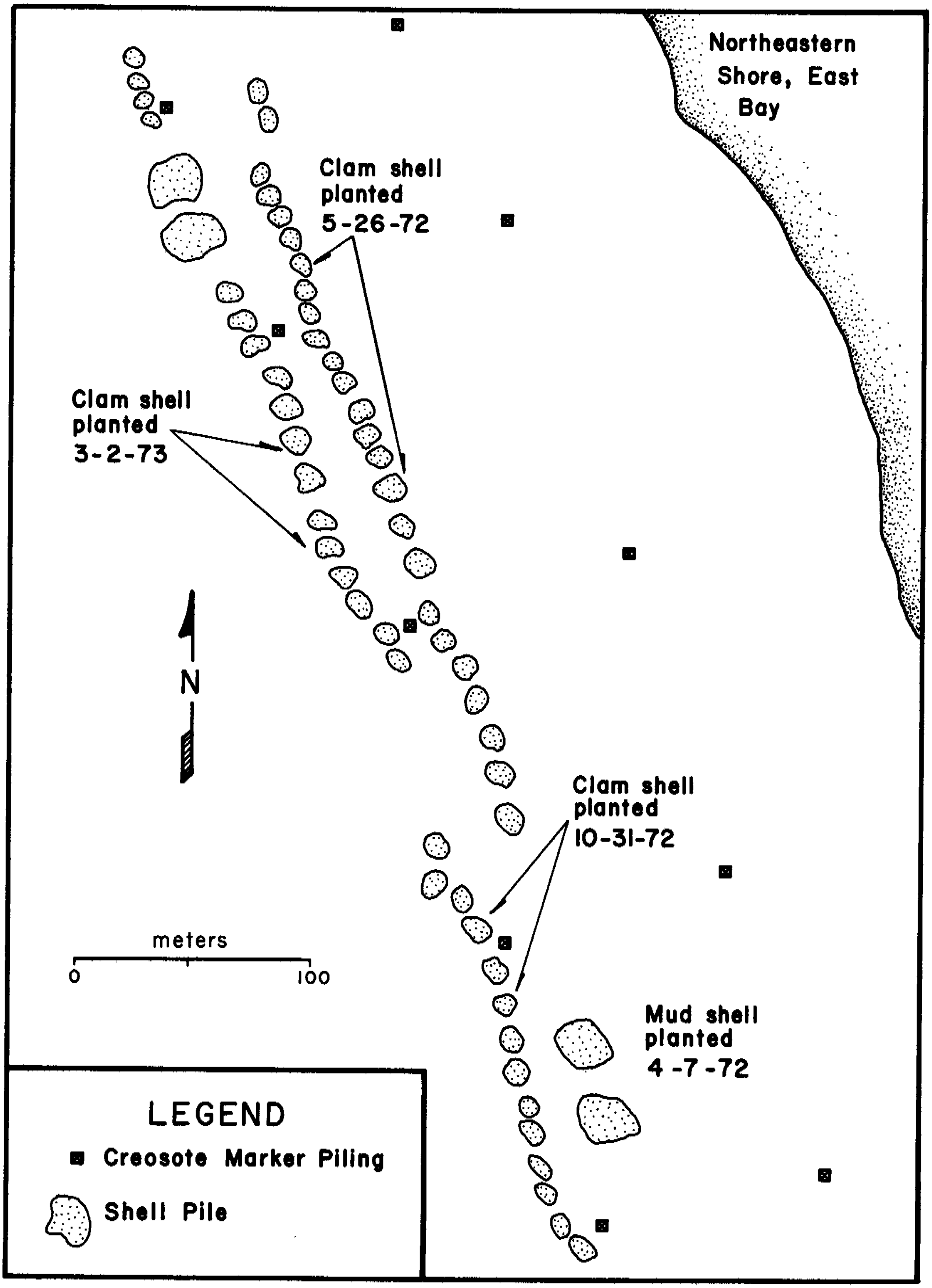

Figure 17. Position of shell plantings, Site E, East Bay.

TABLE 18. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 4/7/72 AT SITE D, JULY 1972 THROUGH NOVEMBER 1973; FEBRUARY AND SEPTEMBER 1974

Site: D, western shore of East Bay

Material: Dredged Mobile Bay oyster shells tonged from conical mounds

Dated planted: 4/7/72

	1972									1973							1974	
Date sampled:	7/21	8/5	8/26	9/5	9/22	9/29	10/13	11/27	12/9	1/31	2/20	3/27	4/11	5/29	6/27	11/3	2/21	9/20
No. shells examined	96	52	90	10	10	10	10	10	10	10	10	10	100	10	10	10	10	10
No. shells with oysters	6	8	39	10	10	10	10	10	9	10	10	9	53	10	8	10	9	10
No. spat and seed oysters	10	11	63	107	104	205	290	68	22	53	56	27	164	44	25	168	53	241
$\bar{x}$ no. oysters per shell	.1	.2	.70	10.7	10.4	20.5	29.0	7.0	2.2	5.3	5.6	2.7	1.6	4.4	2.5	16.8	5.3	24.1
$\bar{x}$ no. oysters per spatted shell	1.6	1.3	1.6	10.7	10.4	20.5	29.0	7.0	2.4	5.3	5.6	3.0	3.0	4.4	3.1	16.8	5.8	24.1
Oyster height range (mm)	6.0-31.0	7.5-42.3	1.0-52.0	.3-43.0	.3-28.0	.3-29.0	.3-31.0	5.0-62.0	4.0-20.0	2.0-41.0	2.0-61.0	3.0-22.0	2.0-58.0	11.0-75.0	11.0-52.0	1.0-45.0	3.0-36.0	1.0-71.0
$\bar{x}$ oysters height (mm)	17.2	21.8	9.9	5.4	2.4	1.9	3.4	21.0	8.2	17.4	18.0	12.8	20.8	30.0	27.7	10.0	10.4	11.5
% oysters .5-10 mm	20.0	18.0	61.5	88.9	97.0	95.2	91.5	25.0	72.7	24.5	21.4	40.7	12.8	0	4.0	91.0	62.2	76.1
% oysters 11-19 mm	30.0	45.4	13.8	8.4	1.9	1.9	6.5	23.5	22.7	20.9	34.2	48.1	43.2	34.0	8.0	7.7	32.0	12.0
% oysters 20-30 mm	40.0		15.3	.9	.9	.9	1.7	29.4	4.5	26.4	21.4	11.1	23.1	36.0	56.0	0	3.7	5.1
% oysters 31-40 mm	10.0	27.0	7.6	.9	0	0	0	16.1	0	22.6	12.5	0	12.8	4.5	16.0	.5	1.8	3.4
% oysters > 40 mm	0	.9	1.5	.9	0	0	.3	5.8	0	5.5	5.3	0	7.9	25.0	16.0	.5	0	3.4

TABLE 19. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 9/16/72 AT SITE D, SEPTEMBER 1972 THROUGH NOVEMBER 1973; FEBRUARY AND SEPTEMBER 1974

Site: D, western shore of East Bay

Material: *Rangia* clam shell planted in conical mounds

Date planted: 9/16/72

	1972						1973					1974			
Date sampled:	9/22	9/29	10/13	10/30	11/27	12/9	2/20	3/27	4/11	6/20	11/3	2/20	9/20 crest	9/20 base	9/20 base
No. shells examined	50	50	25	25	25	25	25	25	25	500	25	25	25	25	25
No. shells with oysters	9	50	21	15	24	23	18	22	24	30	25	25	23	25	25
No. spat and seed oysters	13	76	100	18	84	54	41	39	54	42	53	64	105	143	79
$\bar{x}$ no. oysters per shell	.18	1.5	4.0	.7	3.5	2.3	1.6	1.5	2.1	.08	2.1	2.5	4.8	5.7	3.1
$\bar{x}$ no. oysters per spatted shell	1.4	1.5	4.7	1.2	3.5	2.5	2.2	1.7	22	1.4	2.1	2.5	4.2	5.7	3.1
Oyster height range (mm)	0.3-1.5	0.3-2.5	0.3-11.0	2.0-11.0	3.0-27.0	3.0-28.0	3.0-26.0	5.0-22.0	3.0-22.0	10.0-27.0	3.0-27.0	6.0-36.0	.5-27.0	.5-34.0	.5-37.0
$\bar{x}$ oyster height (mm)	.5	1.5	4.0	6.7	12.5	10.6	11.5	11.5	11.3	18.1	6.7	14.7	7.0	12.1	12.7
% oysters 1-10 mm	100.0	100.0	99.0	88.4	45.8	62.9	51.2	43.5	46.2	0	80.0	28.1	81.3	68.0	59.4
% oysters 11-19 mm	0	0	0	11.1	35.7	25.9	41.4	53.8	48.1	54.7	16.3	46.8	18.0	1.3	0
% oysters 20-30 mm	0	0	0	0	19.0	11.1	7.3	2.5	3.7	45.0	3.7	18.0	.7	26.4	25.3
% oysters 31-40 mm	0	0	0	0	0	0	0	0	0	0	0	6.5	0	3.4	15.1
% oysters > 40 mm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 20. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 10/30/72 AT SITE D, NOVEMBER 1972 THROUGH JUNE 1973

Site: D, western East Bay

Material: *Rangia* clam shell cultch planted to form conical piles

Date planted: 10/30/72

	1972			1973				
Date sampled:	11/27	12/9	12/20	2/20	3/27	4/11	5/29	6/27
No. shells examined	25	25	25	25	25	25	25	25
No. shells with oysters	0	0	0	1	0	0	1	2
No. spat and seed oysters	0	0	0	1	0	0	1	2
$\bar{x}$ no. oysters per shell	0	0	0	.04	0	0	.04	.08
$\bar{x}$ no. oysters spatted shell	0	0	0	.04	0	0	.04	.08
oyster height range (mm)	0	0	0	2.0	0	0	21.0	7.0-14.9
$\bar{x}$ oyster height (mm)	0	0	0	2.0	0	0	21.0	10.5
% oysters .5-10 mm	0	0	100.0	100.0	0	0	0	50.0
% oysters 11-19 mm	0	0	0	0	0	0	0	50.0
% oysters 21-30 mm	0	0	0	0	0	0	100.0	0
% oysters 31-40 mm	0	0	0	0	0	0	0	0
% oysters > 40 mm	0	0	0	0	0	0	0	0

TABLE 21. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 5/8/73 AT SITE D, MAY AND JUNE 1973; FEBRUARY AND SEPTEMBER 1974

Site: D, southwestern East Bay

Material: *Rangia* clam shells planted in conical piles

Date planted: 5/8/73	1973		1974	
Date sampled:	5/29	6/27	2/20	9/20
No. shells examined	25	25	25	25
No. shells with oysters	0	0	23	24
No. spat and seed oysters	0	0	72	57
$\bar{x}$ no. oysters per shell	0	0	2.8	2.2
$\bar{x}$ no. oysters per spatted shell	0	0	3.1	2.3
Oyster height range (mm)	0	0	2.0-31.0	.5-32.0
$\bar{x}$ oyster height (mm)	0	0	12.3	17.8
% oysters .5-10 mm	0	0	45.8	40.3
% oysters 11-19 mm	0	0	45.8	3.5
% oysters 20-30 mm	0	0	6.9	50.8
% oysters 31-40 mm	0	0	1.4	5.2
% oysters > 40 mm	0	0	0	0

TABLE 22. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 4/7/72 AT SITE E, JULY 1972 THROUGH JUNE 1973

Site: E, northeastern East Bay

Material: Mobile Bay dredged oyster shells planted in large conical mounds

Date planted: 4/7/72

	1972							1973				
Date sampled:	7/22	8/26	9/22	9/29	10/12	10/31	12/20	2/20	3/27	4/11	5/29	6/27
No. shells examined	89	100	10	10	10	10	10	10	10	100	10	10
No. shells with oysters	4	36	10	10	10	10	10	9	10	57	3	3
No. spat and seed oysters	4	48	156	197	299	240	85	40	24	182	3	4
$\bar{x}$ no. oysters per shell	.04	.48	15.6	19.7	29.9	24.0	8.5	4.0	2.4	1.82	.3	.4
$\bar{x}$ no. oysters per spatted shell	.04	1.3	15.6	19.7	29.9	24.0	8.5	4.4	2.4	3.1	1.0	1.3
Oyster height range (mm)	14.0-27.0	1.0-42.0	0.3-47.0	0.3-34.0	0.3-29.0	0.3-57.0	3.0-43.0	3.0-44.0	3.0-42.0	4.0-68.0	21.0-30.0	7.0-44.0
$\bar{x}$ oyster height (mm)	22.2	8.6	5.5	2.8	2.5	7.2	11.9	22.9	18.4	25.5	24.3	28.0
% oysters .5-10 mm	0	79.1	79.3	81.0	75.8	76.6	52.0	17.5	16.6	17.0	0	25.0
% oysters 11-19 mm	25.0	8.3	10.8	10.6	6.3	13.7	31.7	22.5	12.5	26.3	0	25.0
% oysters 20-30 mm	75.0	10.0	7.5	8.3	17.9	7.1	14.1	30.0	54.1	26.3	66.6	0
% oysters 31-40 mm	0		1.2	0	0	2.1	1.1	25.0	8.3	26.3	33.3	0
% oysters > 40 mm	0	2.0	1.2	0	0	.5	1.1	5.0	8.3	7.1	0	50.0

TABLE 23. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 5/29/72 AT SITE E, AUGUST 1972 THROUGH JUNE 1973; FEBRUARY AND SEPTEMBER 1974

Site: E, northeastern East Bay

Material: *Rangia* clam shells planted in large conical mounds

Date planted: 5/29/72

	1972						1973					1974	
Date sampled:	8/26	9/22	9/29	10/12	10/30	12/20	2/20	3/27	4/11	5/29	6/27	2/20	9/20
No. shells examined	100	50	50	25	25	25	25	25	25	500	25	25	25
No. shells with oysters	9	45	50	23	21	21	19	17	13	180	16	22	22
No. spat and seed osyters	10	87	84	63	56	52	21	22	15	218	26	39	193
$\bar{x}$ no. oysters per shell	.1	1.7	1.6	2.4	2.2	2.0	.8	.9	.6	.43	1.0	1.6	7.7
$\bar{x}$ no. oysters per spatted shell	1.0	1.9	1.6	2.7	2.6	2.4	1.1	1.2	1.1	1.2	1.6	1.8	8.3
Oyster height range (mm)	2.0-23.5	.3-29.0	.3-34.0	.3-34.0	.4-25.0	2.0-26.0	2.0-29.0	4.0-11.0	5.0-27.0	4.0-33.0	6.0-44.0	5.0-28.0	.5-27.0
$\bar{x}$ oyster height (mm)	7.3	2.9	3.7	6.6	5.5	9.2	10.6	6.8	13.8	15.2	15.8	11.8	9.0
% oysters .5-10 mm	70.0	95.6	88.1	82.2	78.7	67.6	57.1	90.9	33.3	28.3	26.9	53.8	88.0
% oysters 11-19 mm	20.0	2.2	10.7	10.0	14.2	19.2	23.8	9.1	53.3	48.4	46.1	33.0	15.2
% oysters 20-30 mm	10.0	2.2	1.1	6.3	7.1	13.2	19.0	0	13.3	18.8	23.0	12.8	4.9
% oysters 31-40 mm	0	0	0	1.5	0	0	0	0	0	4.5	0	0	0
% oysters > 40 mm	0	0	0	0	0	0	0	0	0	0	3.8	0	0

TABLE 24. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 10/31/72 AT SITE E, FEBRUARY 1973 THROUGH JUNE 1973

Site: E, northeastern shore of East Bay

Material: *Rangia* clam shells planted in conical piles

Date planted: 10/31/72

			1973		
Date sampled:	2/20	3/27	4/11	5/29	6/27
No. shells examined	25	25	25	25	25
No. shells with oysters	0	0	6	12	0
No. spat and seed oysters	0	0	11	15	0
$\bar{x}$ no. oysters per shell	0	0	14	16	0
$\bar{x}$ no. oysters per spatted shell	0	0	1.8	1.2	0
Oyster height range (mm)	0	0	3.0-14.0	10.0-22.0	
$\bar{x}$ oyster height (mm)	0	0	7.4	14.2	0
% oysters .5-10 mm	0	0	81.2	13.3	0
% oysters 11-19 mm	0	0	18.8	73.3	0
% oysters 20-30 mm	0	0	0	13.3	0
% oysters 31-40 mm	0	0	0	0	0
% oysters > 40 mm	0	0	0	0	0

TABLE 25. SPATFALL AND PRODUCTIVITY OF SHELL CULTCH PLANTED 3/2/73 AT SITE E, MARCH THROUGH JUNE 1973; SEPTEMBER 1974

Site: E, northeastern shore of East Bay

Material: *Rangia* clam shells planted in conical piles

Date planted: 3/2/73

	1973				1974
Date sampled:	3/27	4/11	5/29	6/27	9/20
No. shells examined	25	25	25	25	25
No. shells with oysters	0	0	0	0	25
No. spat and seed oysters	0	0	0	0	156
$\bar{x}$ no. oysters per shell	0	0	0	0	6.2
$\bar{x}$ no. spat per spatted shell	0	0	0	0	6.2
Oyster height range (mm)	0	0	0	0	0.5-33.0
$\bar{x}$ oyster height (mm)	0	0	0	0	8.1
% oysters .5-10 mm	0	0	0	0	83.9
% oysters 11-19 mm	0	0	0	0	12.8
% oysters 20-30 mm	0	0	0	0	2.5
% oysters 31-40 mm	0	0	0	0	.6
% oysters > 40 mm	0	0	0	0	0

Setting Observations at Site C

Pairs of cement board tiles suspended 30 cm above bottom were replaced 32 times between April 1, 1972 and August 25, 1973. Exposure periods ranged from 6 to 34 days ($\bar{x}$ = 13.9), and 213 *C. virginica* spat set on the 400 cm^2 of tile surface (Table 26). Most spatfall (72%) occurred between August 24 and October 25, 1972. Setting was light in spring and summer 1972 and negligible in the winter of

TABLE 26. SPATFALL ON CEMENT BOARD TILES, APRIL 1972 THROUGH AUGUST 1973

Site C, Escambia Bay						Site D, East Bay					
Date	Days Exposed	Side I	Side II	Side III	Side IV	Date	Days Exposed	Side I	Side II	Side III	Side IV
4/10	10					4/20	9				
4/20	10					5/9	19				
4/30	10					5/23	14		2		1
5/9	9	6	2	3	1	7/13	51		1		
5/17	8			1		7/21	9	1			1
5/26	9					8/5	15	1	1		
6/14	19					8/26	21	7	7	10	
7/5	21		1			9/5	10	15	2	11	1
7/13	8	5		3		9/13	8	5		1	
7/21	8					9/22	9	38	12	10	2
7/27	6			1		9/29	7	151	63	40	35
8/5	9	2				10/13	14	10	33		
8/24	19	6	4		1	10/30	17	124	30	20	15
9/5	12	12	7	8	3	12/9	12				
9/13	8	2		1		12/20	11				
9/22	9	4	4	4		1/13	24				
9/29	7	21	4	5	2	1/31	18				
10/13	14	28	3	1	3	2/20	20				
10/25	12	23	7	1	8	3/27	34				
11/27	34	6	1		5	4/11	15				
12/9	12					5/15	14				
12/20	11					5/29	14			2	
1/13	24					6/20	21				1
1/31	18					7/6	15				
2/20	20					7/25	19		1	2	
4/11	15										
4/30	19										
5/15	15										
5/29	14			2							
6/20	21			2	1						
7/6	15		1		1						
7/25	19	3									
Totals		118	33	37	25	Totals		352	152	96	55

(Space) = no spat evident

1972-1973. Tile upper surfaces (sides I and III) bore 72% of total spat set.

Barnacles, *Balanus eburneus*, were most abundant foulers; cumulative set was 251.1 per cm^2. Most intense barnacle setting occurred in April 1972, September-October 1972, and May 1973 (Figure 18). Light setting was noted in remaining months. Heaviest setting (55.4%) invariably occurred on the underside of the bottom tile (Surface IV). Lesser sets of 13.7% and 6.0% occurred on the facing tile surfaces (II and III) and 24.9% set on the uppermost surface (I).

Most serpulid worm and *Membranipora* attachments took place between May and November 1972 (Table 27), and setting of both was greatest on tile undersurfaces. Most mussels set during August and September 1972; attachment was greatest on Surface I.

Setting Observations at Site D, East Bay

Tiles suspended 30 cm above bottom were replaced 25 times between April 20, 1972 and August 25, 1973. Exposure periods ranged from 7 to 51 days ($\bar{x}$ = 16.9), and 655 *C. virginica* spat were collected (Table 26). Most setting (94.3%) occurred between September 5, and October 30, 1972. Spatfall was greatest on Surface I (53.7%) and least on Surface IV (8.3%).

Mean cumulative barnacle set was 223 per cm^2, most extensive sets (45.7%) occurring on Surface IV. Although barnacle setting intensity was lower than at Site C, the overall pattern was similar, and attachment was greatest in spring and autumn (Figure 18).

Setting of serpulid worms and bryozoa was also greatest on tile undersides (Table 28). *Membranipora* encrustation was more extensive than at Site C, and colonies flourished in May 1972 and 1973. Serpulid worms were less common than at Site C, attachment occurring primarily in summer 1972. Mussels were generally scarce, and 69% of 124 found had set in September and October 1972. Small numbers of *Crepidula* also set and, like mussels, were most common on tile upper surfaces especially during September and October. As at Site C, the wooden collector frame was frequently covered with 2-5 mm thick films of algae identified as *Navicula* sp. and *Oscillatoria* sp.

Setting Observations in Santa Rosa Sound

Beginning in July 1972, a pair of cement board tiles were suspended 30 cm above bottom (2.2 m depth) at the Gulf Breeze Environmental Research Laboratory east dock. Oyster setting at the Laboratory is generally profuse and has been well studied (Butler, 1955; Forbes, 1967). Tiles were placed there to indicate whether tile material or collector configuration inhibited oyster setting, thus causing poor spatfall noted on East and Escambia Bay tiles, and to obtain comparative spatfall patterns for a saline coastal lagoon.

Tiles were replaced 10 times between July 21, and October 26, 1972; exposure period ranged from 7 to 20 days ($\bar{x}$ = 10.4) (Table 29). A total of 9,615 spat set, but only 10.1% were *Crassostrea virginica*, the remainder being *Ostrea* sp. Both *Ostrea equestis* and *O. frons* commonly set in Santa Rosa Sound (Menzel, 1954). Specific identification of *Ostrea* spat is difficult (Forbes, 1967) and was not attempted in this study. Setting of *C. virginica* was appreciable only in August.

OYSTER POPULATION DYNAMICS AND FUNGAL PARASITOLOGY

Oysters may spawn throughout much of the year (Hopkins, 1948; Ingle and Dawson, 1953; Butler, 1954b; Hopkins et al., 1954; Quick and Mackin, 1971), so identification of discreet year classes is often impossible. In addition, individual oyster growth is highly variable in localized populations (Butler, 1952; Hopkins et al., 1954). Despite these limitations, we have sufficient information to make some assessment of recruitment, growth, spawning, and fungal parasitology of oysters from the Pensacola system.

TIME AND INTENSITY OF SPATFALL

Insufficient spatfall is not a problem in most Gulf coast oyster localities; in fact, setting is often excessive (Hopkins, 1955). Even so, low setting intensity does occur in some places, such as Mobile Bay (May, 1973) and Escambia Bay as demonstrated in this survey, thus making study of spatfall a necessary part of successful oyster culture. Both Brice (1898) and Prytherch (1933) attributed poor oyster productivity of East and Escambia Bays to lack of a consistently adequate spat supply. Butler (1965) showed that setting intensity, duration, and timing fluctuated greatly from year to year in Santa Rosa Sound over a ten year period.

Backcalculations of oyster ages in samples from natural populations in Escambia and East Bays showed a prevalence of oysters from late summer

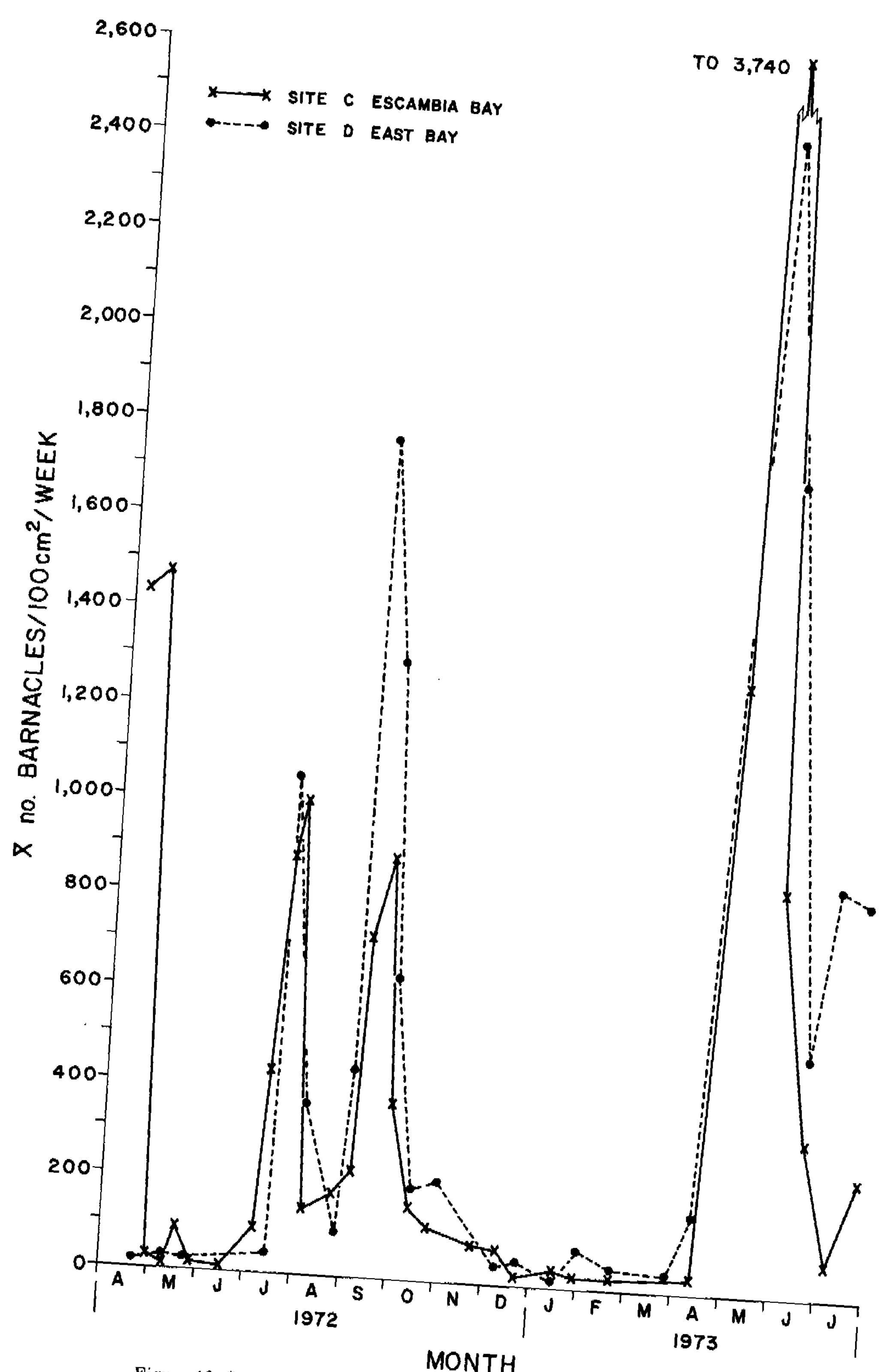

Figure 18. Setting of barnacles on cement board tiles, Site C and Site D.

TABLE 27. ATTACHMENT OF BRYOZOA AND SERPULID WORMS TO CEMENT BOARD TILES, SITE C, EASTERN ESCAMBIA BAY

		Membranipora tenuis (# of cm² covered)				*Eupomatus dianthus* (# of tubes per side)			
		Side				Side			
Date	Days Exposed	I	II	III	IV	I	II	III	IV
4/10/72	10								
4/20	10								
4/30	10								
5/9	9					2			2
5/17	8	13	32	17	55	22	38	8	98
5/26	9	2			6	1	3		2
6/14	19					15	27		
7/5	21	21	10	3	24	3	16	5	2
7/13	8	1	1		2	20	22	3	23
7/21	8	1	3		1	4	6		5
7/27	6				2	7	20	2	9
8/5	9	4			7	182	122	136	267
8/24	19	7	25	1	31	31	93	16	221
9/5	12	1			2	15	27	5	18
9/13	8					4	8	3	9
9/22	9				2	4	20	8	18
9/29	7							1	
10/13	14						2	2	3
10/25	12					57	57	6	168
11/27	34	6			1	2	3	1	29
12/9	12								
1/13-73	24	9			9				
1/31	18								
2/20	20	3							
4/11	15								
4/30	19								
5/15	15	1			3				
5/29	14								
6/20	21								
7/6	15								6
7/25	19				2	7			4
Totals		69	71	21	147	376	464	196	857

(Space) = none evident

and/or autumn spatfalls (Tables 30, 31). A similar trend was noted in direct examination of planted cultch and cement board tiles; spatfall in spring and early summer 1972, 1973, and 1974 was meager. Bimodal patterns of oyster setting in which autumn spatfalls predominate have also been noted in Mobile Bay (Hoese et al., 1972) and in Galveston Bay (Moore and Trent, 1971).

Although spatfall intensity on cultch plantings varied throughout the area, a reduction with increasing proximity to northern Escambia Bay was apparent. This is also suggested by relative scarcity of smaller submarket oysters (< 70 mm height) from Escambia Bay natural populations when compared to those from East Bay (Tables 30, 31; Figure 19). Quick (1971) stated a similar condition must have prevailed prior to the September 1971 epizootic. In addition to local differences in spatfall intensity, overall intensity of autumn setting in both natural and cultivated populations increased from almost negligible in 1970 to progressively better levels in 1971, 1972, 1973, and 1974.

Reasons for variations in spatfall intensity cannot be determined conclusively without further intensive study. May (1973), however, reported that a comparable pattern of low spatfall intensity in Mobile Bay was caused by inhibition of spawning or spatfall due to low salinities during spring freshwater flooding, and/or by mortalities of larvae and spat due to extremely low summer dissolved oxygen. Since such conditions also occurred frequently in East and Escambia Bays, similar causes of lessened spatfall were likely. This is particularly supported by paucity of spatfall near eutrophic north-

Table 28. ATTACHMENT OF BRYOZOA AND SERPULID WORMS TO CEMENT BOARD TILES, SITE D, WESTERN EAST BAY

Date	Days Exposed	*Membranipora tenuis* (# of cm^2 covered) Side I	II	III	IV	*Eupomatus dianthus* (# of tubes per side) Side I	II	III	IV
4/20/72	9	2	1	1	2				
5/9	19	94	15	11	96				
5/23	14	10	11		10		2		1
7/13	51	67	93	82	74	10	35	6	3
7/21	9	1				6	11	1	56
8/5	15	1			1		7		9
8/26	21	1	3	1	3		30	6	8
9/5	10	1			2	5	12	5	10
9/13	8	1			2	3	3	4	9
9/22	9								
9/29	7	4					2		
10/13	14	5	3				1		
10/30	17	10	2						
12/9	12								
12/20	11								
1/13/73	24	3			3				
1/31	18	3			2				
2/20	20								
3/27	34	2							
4/11	14								
5/15	14								
5/29	14	24	20	50	53				
6/20	21								
7/6	15	2							
7/25	19	4		6					
Totals		235	148	151	248	24	103	22	96

(Space) = none evident

TABLE 29. ATTACHMENT OF OYSTERS AND FOULING ORGANISMS TO CEMENT BOARD TILES, EAST DOCK, GULF BREEZE ENVIRONMENTAL RESEARCH LABORATORY, SANTA ROSA SOUND

		C. virginica				*Ostrea* sp.				*Balanus eburneus* & *B. amphitrite niveus*				*Eupomatus dianthus* & *E. protocula*			
		Side				Side				Side				Side			
Date	Days Exposed	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
7/21/72	7	2	2	3	6				1	1	4	1	11	39	747	30	16,300
7/30/72	9		3						1	9	17	2	3	1,720	15,000	2,940	16,000
8/07/72	8	1	20	1	25	12	12		5	35	22	3	158	33	4,100	234	8,040
8/27/72	20	18	159	13	256	10	49	29	95	70	47	7	300	173	3,020	289	4,260
9/05/72	9	63	20	17	134	226	69	4	328	208	2	3	1,040	40	18	1	47
9/13/72	8	9	28	12	50	382	300	87	664	20	30	8	383	52	1,680	36	4,260
9/24/72	11	6	29	14	28	567	646	221	817	10	6	2	28	36	86	10	373
10/02/72	8	4	2	5	7	526	474	126	489	15	6	1	42	10	18		49
10/16/72	14	1	1	1	14	65	20	4	314	28			242	49	3		4,210
10/26/72	10			8		441	211	1,102	215	247	326	289	1,460	2	2	1	4

TABLE 30. OYSTER AGE AND GROWTH, SOUTHERN ESCAMBIA BAY

Date Collected and Station	Height Right Valve	Marginal Increment	Age (Months)	Month Set	Spawning Shelves
11/25/71	80.0 mm	15 mm	13	Oct.	—
E-39	91.0	18	13	Oct.	—
	85.0	24	25	Oct.	1
	87.0	8	25	Oct.	1
	93.0	5	25	Oct.	1
	100.0	10	37	Oct.	2
	98.0	16	25	Oct.	1
	104.0	8	26	Sept.	1
	100.0	19	25	Oct.	2
	105.0	8	31	Apr.	2
	127.0	5	31	Apr.	2
	125.0	4	38	Sept.	1
$\bar{x}$ =	92.0	12.5	26.2	—	1.17
12/21/71	63.0	6	38	Oct.	—
E-59	70.0	10	26	Sept.	—
	77.0	7	19	May	—
	74.0	4	27	Sept.	1
	78.0	7	39	Sept.	1
	70.0	5	19	May	1
	81.0	13	51	Sept.	1
	111.0	10	43	May	2
	108.0	3	55	May	1
	115.0	2	39	Sept.	2
	105.0	6	51	Sept.	2
	112.0	10	55	May	1
$\bar{x}$ =	88.5	7.3	38.3	—	.92
2/ 6/72	60.5	6	16	Oct.	—
E-90	71.0	9	40	Oct.	1
	72.0	10	40	Oct.	1
	91.0	3	44	June	2
	81.0	7	40	Oct.	1
	75.0	7	40	Oct.	1
	77.5	12	32	June	—
	72.5	8	32	June	—
	82.5	5	40	Oct.	2
	85.5	12	40	Oct.	1
	110.0	9	54	Oct.	1
	112.2	7	54	Oct.	2
$\bar{x}$ =	82.6	7.9	39.0	—	1.00
2/10/72	76.0	10	46	May	—
	72.0	7	40	Oct.	—
	82.0	12	32	June	—
	88.0	10	40	Oct.	—
	110.0	20	40	Oct.	1
	81.0	8	40	Oct.	—
	79.0	13	40	Oct.	—
	75.0	10	33	May	—
	96.0	12	45	May	—
	100.0	22	40	Oct.	1
	102.0	14	52	Oct.	—
	86.0	8	40	Oct.	—
	90.0	17	40	Oct.	—
	86.0	10	45	May	—
	104.0	20	40	Oct.	1
	82.0	10	40	Oct.	—
	107.0	9	66	Oct.	2
	77.0	9	40	Oct.	1
	93.0	22	40	Oct.	—
	72.0	17	40	Oct.	—
	77.0	14	33	June	1
	74.0	10	53	Oct.	—

TABLE 30. OYSTER AGE AND GROWTH, SOUTHERN ESCAMBIA BAY (Continued).

Date Collected and Station	Height Right Valve	Marginal Increment	Age (Months)	Month Set	Spawning Shelves
	72.0 mm	15 mm	40	Oct.	—
	59.0	27	17	Oct.	—
x̄ =	84.9	13.5	40.6	—	.29
4/20/72	73.5	17.3	30	Oct.	—
	70.0	12	30	Oct	—
	71.0	12	42	Oct.	—
	82.0	10	42	Oct.	—
	83.0	14	47	May	—
	101.0	18	54	Oct.	1
	82.0	7	42	Oct.	2
	87.0	10	42	Oct.	1
	84.0	20	30	Oct.	—
	81.0	12	30	Oct.	—
	123.0	25	54	Oct.	1
	130.0	22	66	Oct.	1
x̄ =	79.2	14.9	42.4	—	.50
12/20/72	66.2	10	14	Oct.	—
	70.0	9	14	Oct.	—
	71.0	30	14	Oct.	—
	75.0	6	14	Oct.	—
	78.8	27	14	Oct.	—
	74.0	30	14	Oct.	—
	84.0	22	14	Oct.	—
	80.5	20	14	Oct.	—
	74.0	20	14	Oct.	—
	78.0	6	14	Oct.	—
	87.5	19	14	Oct.	—
	94.0	15	14	Oct.	—
x̄ =	77.5	17.8	14	—	0

TABLE 31. OYSTER AGE AND GROWTH, EAST BAY

Date Collected and Station	Height Right Valve	Marginal Increment	Age (Months)	Month Set	Spawning Shelves
11/30/71	64.0 mm	7.0 mm	13	Oct.	—
E-44	70.0	22.0	13	Oct.	—
	70.0	23.0	13	Oct.	—
	58.0	4.0	26	Sept.	1
	83.0	11.0	26	Sept.	1
	80.0	8.0	26	Sept.	1
	97.0	2.0	33	Feb.	1
	82.0	4.0	42	May	2
	110.0	13.0	42	May	1
	78.0	6.0	42	May	1
	84.0	4.0	38	Sept.	1
	94.0	2.0	50	Oct.	3
x̄ =	80.8	8.7	30.1	—	1.0
12/27/71	62.0	10.0	27	Sept.	—
E-64	70.0	12.0	27	Sept.	—
	60.0	66.0	27	Sept.	—
	64.0	4.0	27	Sept.	—
	65.0	5.0	27	Sept.	—
	77.0	8.0	27	Sept.	—
	64.0	10.0	19	May	—
	81.0	8.0	27	Sept.	—
	84.0	10.0	39	Sept.	—
	83.0	10.0	39	Sept.	—
	96.0	12.0	33	May	1
	101.0	8.0	39	Sept.	—
x̄ =	75.5	8.5	32.4	—	.08

TABLE 31. OYSTER AGE AND GROWTH, EAST BAY (Continued).

Date Collected and Station	Height Right Valve	Marginal Increment	Age (Months)	Month Set	Spawning Shelves
1/27/72	63.0 mm	11.0 mm	20	May	—
E-86	70.0	—	—	—	—
	76.0	10.0	15	Oct.	—
	86.0	7.0	39	Oct.	2
	82.0	15.0	20	May	—
	86.0	7.0	39	Oct.	—
	92.0	10.0	40	Sept.	1
	86.0	5.0	33	May	1
	105.0	13.0	40	Sept.	0
	83.0	2.0	46	May	1
	108.0	7.0	46	May	—
	90.0	10.0	52	Sept.	2
$\bar{x}$ =	85.5	8.0	36.3	—	.63
2/14/72	110.0	14.0	56	June	2
E-95	86.0	7.0	40	Oct.	0
	112.0	16.0	44	June	1
	101.0	10.0	53	Sept.	2
	108.0	7.0	53	Sept.	—
	90.0	10.0	41	Sept.	—
	91.0	11.0	53	Sept.	0
	118.0	13.0	65	Sept.	2
	108.0	10.0	65	Sept.	0
	93.0	11.0	53	Sept.	1
$\bar{x}$ =	91.6	10.9	52.3	—	.8
4/20/72	60.0	12.0	30	Oct.	—
	64.0	20.0	30	Oct.	—
	64.0	20.0	30	Oct.	—
	76.0	10.0	54	Oct.	—
	79.0	17.0	46	June	—
	70.0	18.0	42	Oct.	1
	77.0	10.0	42	Oct.	—
	71.0	10.0	42	Oct.	—
	83.0	12.0	42	Oct.	—
	81.0	7.0	46	June	1
	78.0	18.0	42	Oct.	—
	80.0	30.0	42	Oct.	—
$\bar{x}$ =	73.5	15.3	40.6	—	.16
12/20/72	54.5	8.0	14	Oct.	—
	62.0	10.0	21	May	—
	61.5	13.0	14	Oct.	—
	80.5	15.0	15	Sept.	—
	61.5	12.0	15	Sept.	—
	81.0	18.0	21	May	—
	85.5	7.0	27	Sept.	—
	115.5	14.0	39	Sept.	1
	86.0	5.0	39	Sept.	—
	99.5	9.0	39	Sept.	—
	89.0	7.0	39	Sept.	1
	100.0	10.0	31	May	—
$\bar{x}$ =	81.3	10.6	26.1	—	.16

ern Escambia Bay.

AGE AND GROWTH

Backcalculated ages of tonged Escambia Bay submarket and market oysters (Table 30; Figure 20) ranged from 13-66 months ($\bar{x}$ = 34.6 ± 1.46); those for East Bay oysters (Table 31; Figure 20) ranged from 13-65 months ($\bar{x}$ = 35.3 ± 1.54). Although estimates were not obtained from extensive examination of large numbers of oysters and were done over a period of six months, we feel they are representative of oysters observed throughout the remainder of the study.

Marginal increments (width of new shell zone)

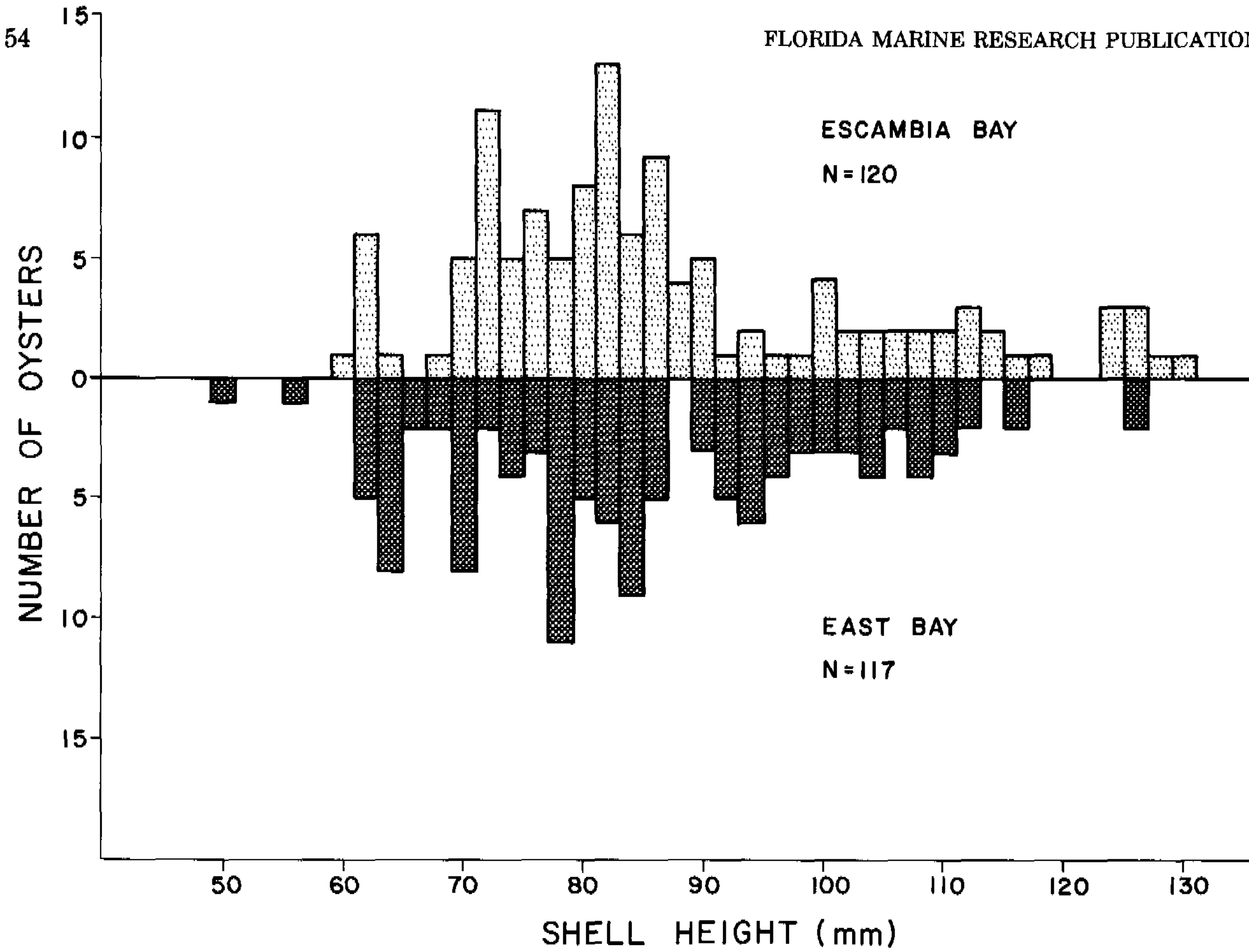

Figure 19. Size frequency of oysters from selected stations in Escambia Bay and East Bay, October 1971 through April 1972.

can also provide age and growth information. These increments generally reflect extent of new shell formation (approximating growth) subsequent to periods of reduced shell formation normally occurring in summer (c.f. Butler, 1952; Quick and Mackin, 1971). Oysters collected in April 1972 had almost completed the winter shell growth period, so their marginal shell increments represented most of that winter's growth. This increment in Escambia Bay (Table 30) ranged from 7 to 25 mm ($\bar{x}$ = 12.3 ± 0.71) and from 7 to 30 mm ($\bar{x}$ = 11.4 ± 1.01) in East Bay (Table 31).

Above age and marginal growth measurements indicate similar oyster growth in both bays despite inclusion of some mixed year classes. Testing for adequacy of these samples (power of a normally distributed variable; Brownlee, 1965) showed them to be sufficient (E. E. Gallaher, University of South Florida, St. Petersburg, Florida, personal communication). Most market oysters were 30 to 36 months old and had grown 20-25 mm per year. This rate is approximately 50% less than that given by Ingle and Dawson (1953) for annual growth of oysters at Apalachicola, Florida, but is in accord with the estimate of Butler (1954b) that most Gulf coast oysters require at least three years to reach market size (76-100 mm).

Rapid growth to market size by oysters set just after the September 1971 epizootic exemplified extreme variation that must be dealt with when characterizing growth rates throughout a large estuarine system. By December 1972, this distinctive population of post-epizootic set comprised the majority of oysters in Escambia Bay and repesentative samples ranged in height from 66.0 to 94.0 mm ($\bar{x}$ = 77.5 ± 2.25) (Table 30). Average age was 14 months, and included two winters, outer valves were thin, relatively smooth, and showed evidence of reduced summer growth. East Bay samples (Table 31) similarly contained rapidly growing market oysters from autumn 1971 spatfalls, but also included slower growing oysters from previous spatfalls.

Oysters growing on planted cultch also exhibited growth variations. For example, shell planted in September 1972 at Site D during peak spatfall bore 10 mm spat within one month and 20 mm spat the following month (Table 19). This rate was comparable to that found in autumn 1971 in Escambia Bay; if sustained, these oysters would have exceeded 76 mm by autumn 1973. However, during sampling at Site D in November 1973 and February 1974, largest oysters were only 25-35 mm in height. These were obviously from the autumn 1972 set as evidenced by a band of reduced shell growth formed in summer 1973. Further indication of abnormally slow growth at Site D was noted among some two year old oysters in September 1974 that were only 24-34 mm in height and had thickened valves displaying two summer bands (Table 19).

These small scale variations were exceptions. Typical (previously described) growth occurred in many instances at Sites C, D, E. Most 1973 spatfall apparently occurred between September and November. By September 1974, seed from this spatfall had one summer growth band and ranged in height from 15 to 41 mm ($\bar{x}$ = 28.4 ± 1.18; n = 48) at Site C and from 22 to 32 mm ($\bar{x}$ = 26.7 ± 1.83; n = 7) at Site D. Similar patterns were noted on

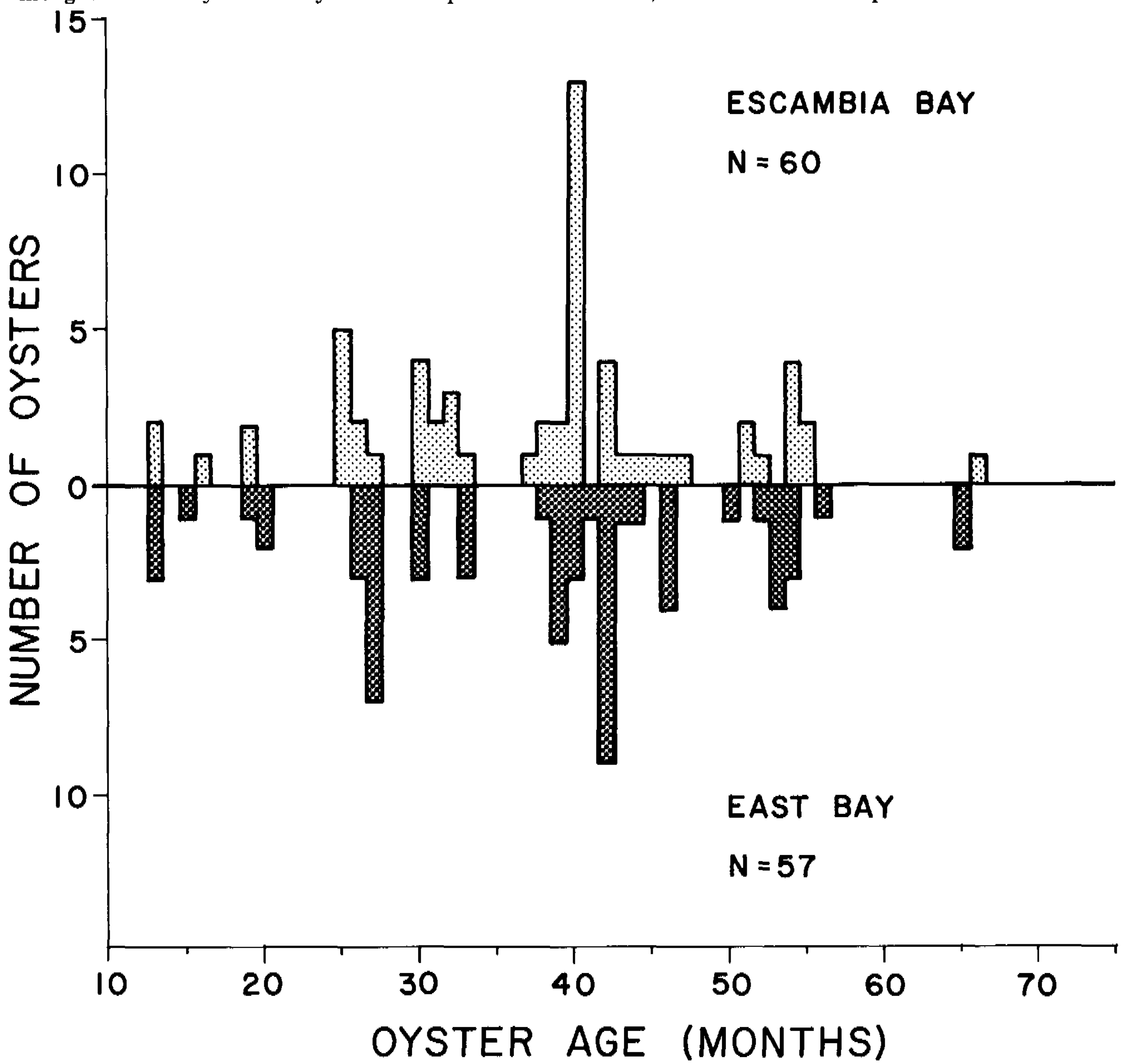

Figure 20. Age frequency of oysters from selected stations in Escambia Bay and East Bay, October 1971 through April 1972.

oysters approximately one year old at Site E; heights ranged from 23 to 33 mm ($\bar{x}$ = 25.6 ± 2.03; n = 5). These values correspond with each other and with those noted previously for natural oyster populations, and may be the most meaningful estimates of annual growth in this bay system.

INCIDENCE OF SPAWNING

When oysters spawn, they commonly produce abrupt, shelflike sculpture (spawning shelves) on valve surfaces as a consequence of reduced linear shell formation (Quick and Mackin, 1971). Presence of this feature was investigated on natural oysters from Escambia Bay (Table 30) and East Bay (Table 31).

Little can be determined regarding spawning incidence. Few oysters bore one or more spawning shelves and there was a perplexing decrease in the mean number of shelves per oyster in both bays (Figures 21, 22). This was not entirely due to inclusion of younger or smaller oysters. Lowered incidence of spawning shelves may have several explanations. Low salinities reduce gametogenesis in oysters (Butler, 1949); periods of reduced salinities in 1969-71 possibly caused spawning to be less frequent or of lowered intensity so shelves did not form or were too small to be identified. There is also the chance that there was some selective mortality of multiple spawned oysters (such as from fungal parasites) in 1972-73. Without more study of the diagnostic value of oyster spawning shelves in these bays, such inferences are speculative.

EFFECTS OF FUNGAL PARASITES

Labyrinthomyxa marina infections (dermo disease) in oyster populations (incidence) and in individuals (intensity) normally reach peaks in late August or early September of each year, primarily in response to concurrent temperature maxima. Minimal infections are usually found in December to February (Quick and Mackin, 1971).

Expected maxima certainly occurred in Escambia Bay in 1971 when massive mortality was noted. Curiously, peak infections were not detected in East Bay until November and December. Infections reached summerlike levels of 83% total incidence and 2.0 weighted incidence (Figure 23). Even in late January, an unseasonably high 41.6% total incidence (0.67 weighted) remained. Escambia Bay oysters also retained rather high infection through the winter, with minimums of 50% incidence (0.92 weighted) in December 1971 (Figure 24). Despite rather high rates of parasitism, incidence of potentially lethal infection remained near normal at < 10% in both groups until February 1972, when it began to rise.

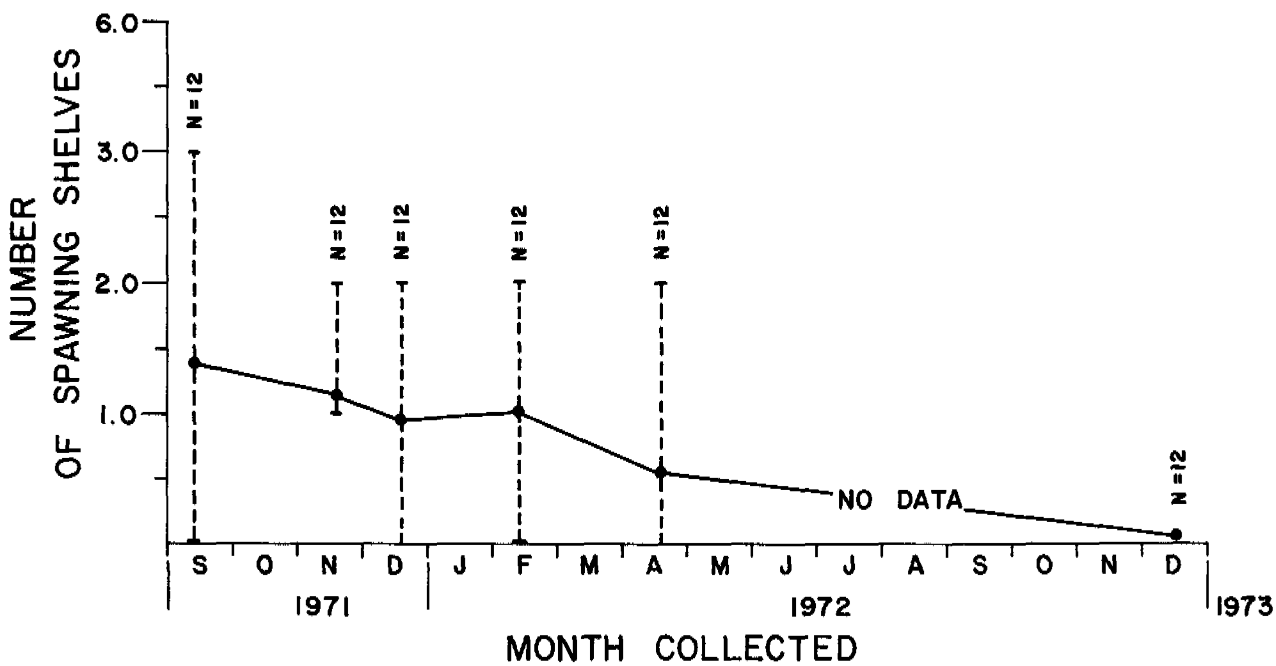

Figure 21. Number (range) and mean incidence of spawning shelves, Escambia Bay oysters, September 1971 through December 1972.

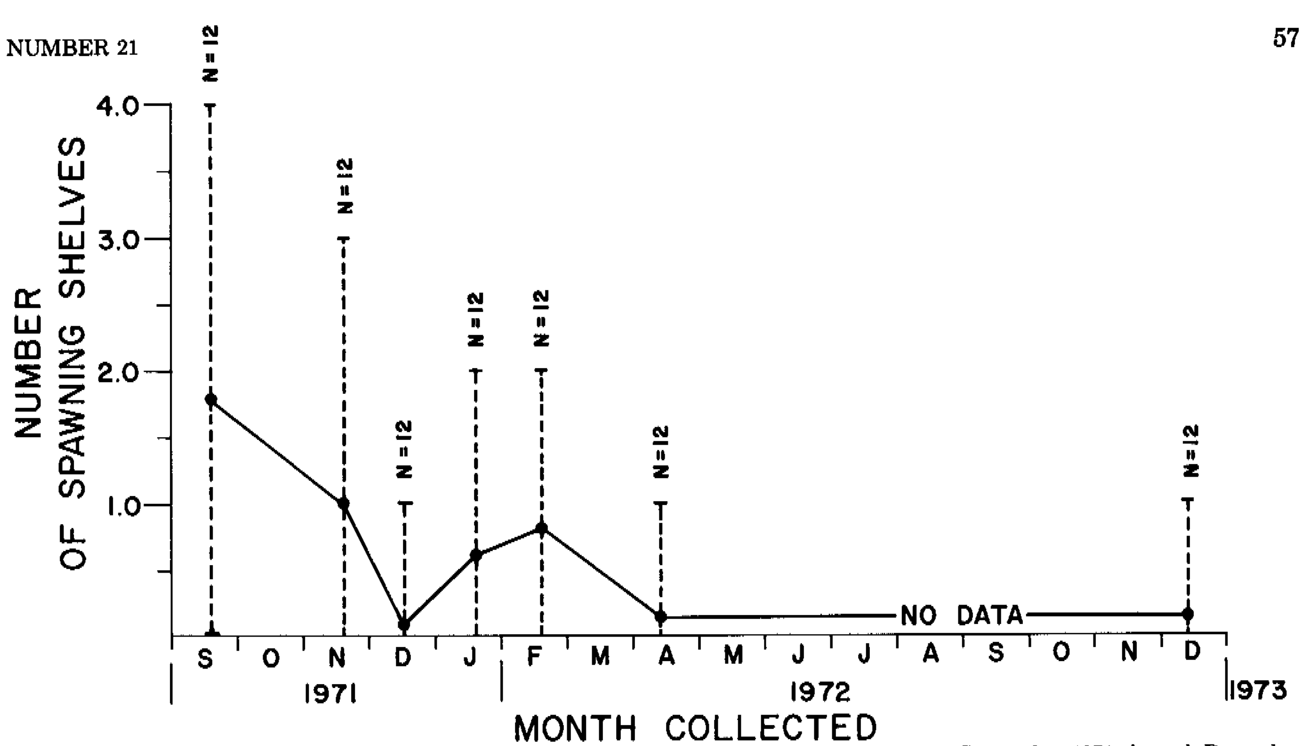

Figure 22. Number (range) and mean incidence of spawning shelves, selected East Bay oysters, September 1971 through December 1972.

For Escambia Bay oysters, all infection parameters showed a marked rise in spring 1972. There was a sampling hiatus from April to December of that year, so outcome of this rise was not measured. Even in December 1972, infection levels were still unseasonably high. These parameters probably rose to lethal levels and, by killing many older spawned oysters (typical for this parasite), accounted for lack of older oysters in December 1972 samples (Figures 22, 23). An epizootic was not reported during this summer, but mortalities could have been inconspicuous due to the extended period over which deaths from *L. marina* commonly occur, and rapidity with which meats of dead oysters are removed by scavengers.

CONDITION OF OYSTER MEATS

Normal seasonal fluctuation of meat size (percent shell cavity filled) and condition (condition index, C.I.) is readily seen in Escambia and East Bay oysters (Figures 25, 26). As expected in northern Gulf oysters, size and condition were poor in September 1971, but improved during cooler months.

CONCLUSIONS

During both the reconnaissance survey and rehabilitation sampling, abundance of oysters and foulers declined with increasing proximity to northern Escambia Bay. This feature, plus the decline of Escambia Bay oyster stocks seen in past years, could stem from natural factors (c.f. Butler, 1954b) as well as from degraded water quality (Quick, 1971; Walsh, 1972). Oyster production in this bay system has historically been erratic (Brice, 1898; Prytherch, 1933) and, as in Mobile Bay (May, 1972, 1973), unfavorable salinities, depressed oxygen, and other naturally occurring ecological conditions can cause spatfall failures and fluctuations. Hopkins (1969) and Young (1971) reported, however, that chronically degraded water quality caused depletion of Escambia Bay seagrass beds and reductions in benthic invertebrate populations.

The reconnaissance survey and ecological observations of tiles and cultch indicate that moderate setting of *Membranipora* and barnacles occurs primarily in April and May. These are principal oyster foulers, but levels are seldom inimical to oyster cultivation. As salinities increase in summer, *Cliona* sponge, serpulid worms, and other macroinvertebrates also become common. Prolonged periods of high salinity (> 25 ‰) foster proliferation of *Thais* drills, *Ostrea* spp., and xanthid crabs. These become especially numerous on natural reefs in southern East Bay, but may also become numerous on cultch plantings in other areas during drought years.

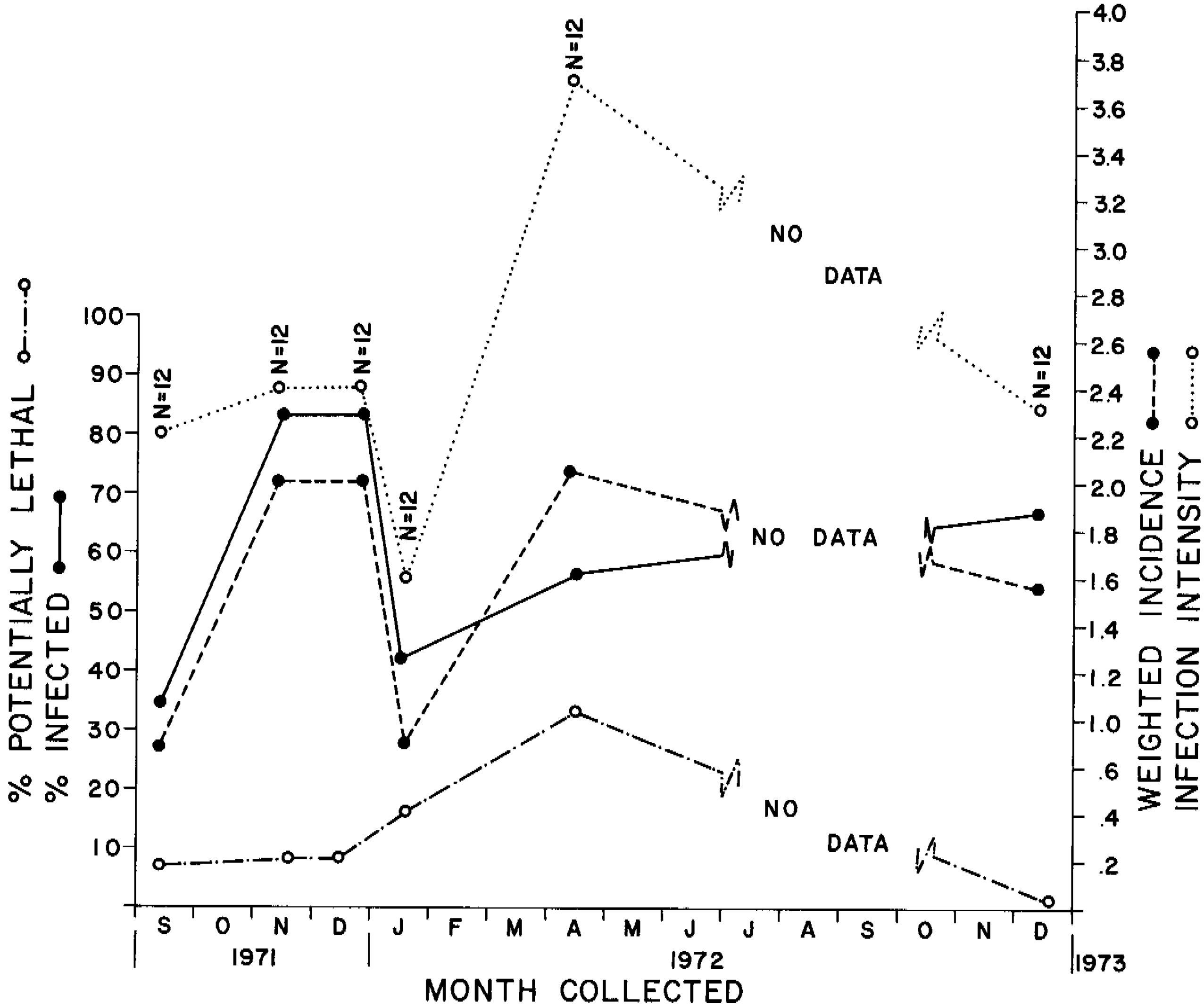

Figure 23. Incidence and intensity of *Labyrinthomyxa* in East Bay oysters.

Siltation is a major problem in some natural and cultivated areas; accumulations were greatest on lower portions of shell piles and were particularly extensive on plantings in more northerly portions of Escambia Bay. Filamentous algae, such as *Polysiphonia* sp., *Oscillatoria* sp., and the pennate diatom, *Navicula* sp., occasionally covered shells from lowest portions of cultch piles.

Primarily because of insufficient spatfall, productivity of shell plantings was low in Escambia Bay and only slightly better in East Bay for the period covered by this report. As evidenced by both tong samples and diving observations (Figure 27), spat and seed oysters were generally scarce on upper portions of most shell piles, but became more common along lowermost portions. This unevenness of distribution over shell pile surfaces, plus irregular configurations of individual piles and variability of oyster growth rates, setting, and mortality, prevented accurate calculation of productivity. Mean and maximum shell heights of oysters from shell mounds indicated some set in autumn 1972 that should have been harvestable by autumn 1975. Oysters set in autumn 1973 were approximately 25-35 mm by autumn 1974, and should also have reached legal size by early spring 1976. Some oysters set on natural reefs during autumn 1971 were of legal size by autumn 1972. Growth was approximately 5 mm per month in winter.

The potential for rehabilitation and/or commercial cultivation of oysters is not constant throughout the Pensacola Bay System. Following the rationale of Galtsoff (1964), we used data presented herein, historical sources (Brice, 1898; Prytherch, 1933) and general principals of estuarine ecology to summarize the potential fitness of selected areas (Table 32) for oyster cultivation. Although most areas possessed only poor or marginal potential (Table 33) some, such as East Bay, show promise assuming application of progressive cultivation techniques. This is supported by low incidence of oyster predation and fouling, good quality, and occasionally rapid growth of sampled oysters. This potential is also suggested by our most recent samples (September 1974) which showed that cultch at sites C, D, and E often bore many more spat and seed oysters than necessary for successful resource maintenance. Several years of observation are needed to evaluate outcome of shell plantings, particularly since long-term productivity was an original objective of the rehabilitation program. It is probable, however, that inherent drawbacks of public oyster propagation and free fishing of natural reefs (c.f. Galtsoff, 1943) will prevent yields from attaining magnitudes possible on private, well-managed leases.

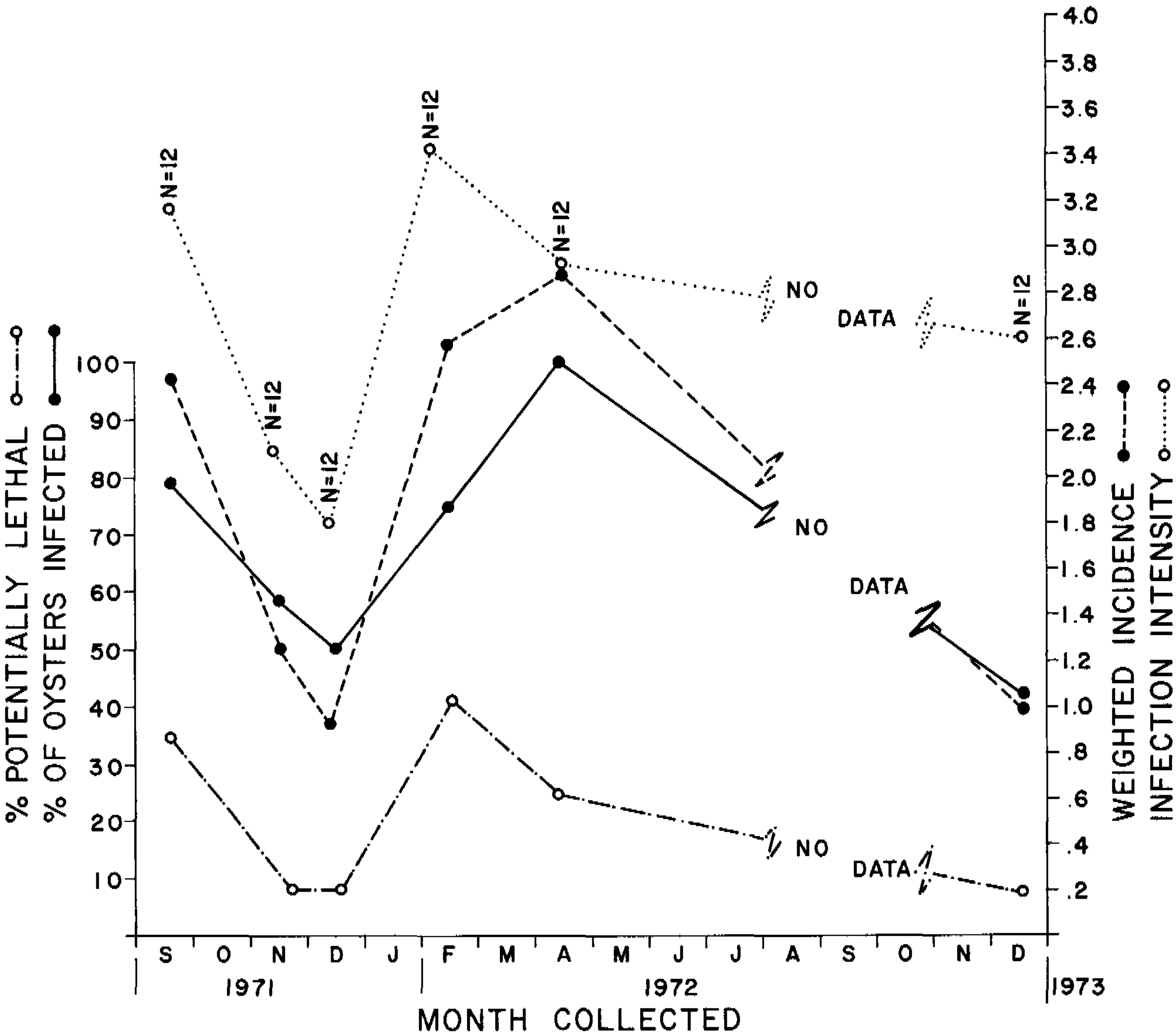

Figure 24. Incidence and intensity of *Labyrinthomyxa* in Escambia Bay oysters.

TABLE 32. DESCRIPTION OF AREAS USED FOR ASSESSMENT OF OYSTER GROWING POTENTIAL WITHIN PENSACOLA ESTUARY.

Area	Description
I	Northern Escambia Bay, all longshore shelves North of Interstate Highway 10 bridge.
II	Eastern Escambia Bay, longshore shelf from I-10 bridge to Trout Bayou.
III	Eastern Escambia Bay, longshore shelf from Trout Bayou to a point due East of Channel Marker No. 7.
IV	Eastern Escambia Bay, longshore shelf from preceeding point to Hernandez Pt.
V	Western Escambia Bay, longshore shelf from I-10 bridge to Gaberrone Pt.
VI	Western Escambia Bay, longshore shelf from Gaberonne Pt. to Magnolia Bluff.
VII	Blackwater Bay, all longshore shelves North of a line extended due West of Escribano Pt.
VIII	Eastern East Bay, longshore shelf from Escribano Pt. to mouth of East Bay River.
IX	Southern East Bay, longshore shelf from mouth of East Bay River to Redfish Pt.
X	Western East Bay, longshore shelf from due West of Escribano Pt. to White Pt.
XI	East Bay, longshore shelf between Garcon Pt. and White Pt.

TABLE 33. OYSTER CULTURE POTENTIAL AND FACTORS OF INFLUENCE FOR AREAS WITHIN PENSACOLA ESTUARY.

Condition Code: 1 = Unsuitable; 2 = Marginal, but not greatly detrimental; 3 = Adequate (average); 4 = Better than average; 5 = Factor greatly advantageous

Factor or Condition	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Pollution from domestic or industrial sources	1	2	2	3	1	1	1	4	3	3	4
Amount of bottom firm enough for cultch planting	1	2	3	5	1	1	1	4	3	3	2
Potential as indicated by abundance of natural oysters	1	2	3	3	2	3	1	4	3	3	3
Potential as indicated by nearby rehabilitation sites	1	2	2	3	NA	NA	NA	4	NA	3	3
Temperature	3	3	3	3	3	3	3	3	3	3	3
Normal salinity regime	2	2	3	3	2	3	3	3	2	3	3
Salinity regime expected during floods	1	1	1	1	1	1	1	2	4	1	3
Salinity regime expected during droughts	4	4	3	2	4	3	4	1	1	3	2
Sedimentation	2	2	3	3	1	3	1	3	3	3	3
Predation to be expected	4	4	4	2	3	3	4	2	2	4	3
Parasitism to be expected	4	4	3	2	4	3	4	2	2	3	3
Adequacy of spatfall	1	2	2	3	2	3	2	4	3	3	3
Annual growth	2	2	3	3	2	3	2	4	4	3	3
Competition from fouling organisms	4	4	4	4	4	3	4	3	2	3	3
Overall score:	31	36	39	40	30	33	31	43	35	41	38
Mean score:	2.2	2.6	2.8	2.9	2.1	2.5	2.4	3.0	2.7	2.9	2.7

Score interpretation:
a) < 2.0 = usually unsuitable, no potential.
b) > 2.0 - < 2.4 = poor potential, seldom consistently productive.
c) > 2.4 - < 2.8 = limited potential.
d) > 2.8 - < 3.2 = commercial potential good, conditions usually adequate.

There is also the possibility that natural oyster recruitment can be increased to more adequate levels to support the resource if pollution is abated and spatfall becomes greater. For example, depressed oxygen in East Bay, and especially Escambia Bay, is partially due to extremely high dissolved oxygen demand created by numerous sources of domestic and industrial pollution (FWPCA, 1970; Florida Coastal Coordinating Council, 1971).

Private oyster cultivation on leased and unproductive bottoms could also be beneficial since spat production from these brood stocks may contribute to overall oyster recruitment on public natural reefs. More cultch can be added to oyster production areas by proper disposal of spoil from future channel dredging in both bays.

ADDENDUM

In December 1975, follow-up inspection of Escambia and East Bay rehabilitation sites disclosed large numbers of seed oyster boxes. There were no live spat, larger oysters, or fouling organisms. Abnormally low salinities (< 2.0 ‰) throughout Escambia and East Bays from at least August through September 1975 (Mr. William Young, Florida Department Environmental Regulation, personal communication) resulting from near record flooding of the Escambia River this period (Mr. Roger Ruminick, U. S. Department Interior Geological Survey, personal communication) were undoubtedly responsible for this massive mortality.

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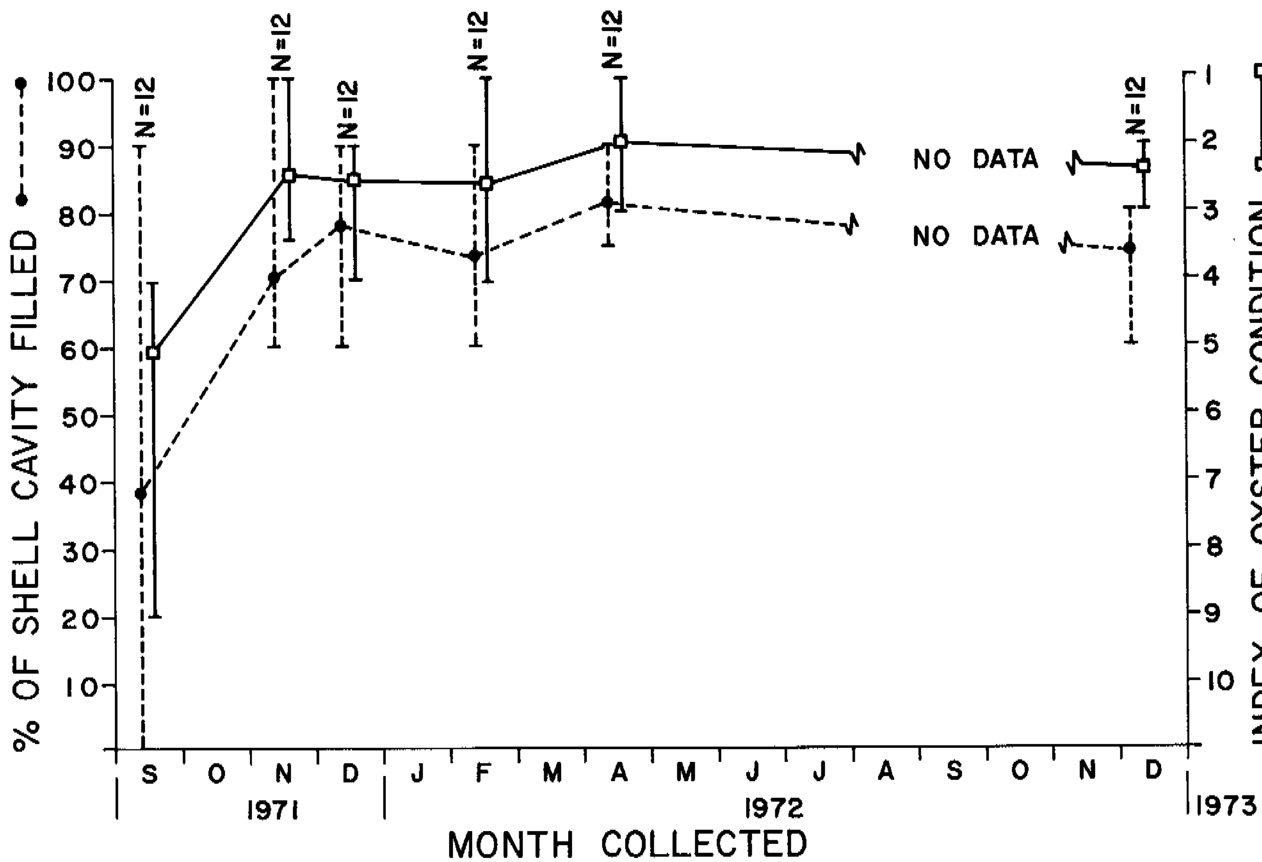

Figure 25. Meat size and condition of Escambia Bay oysters.

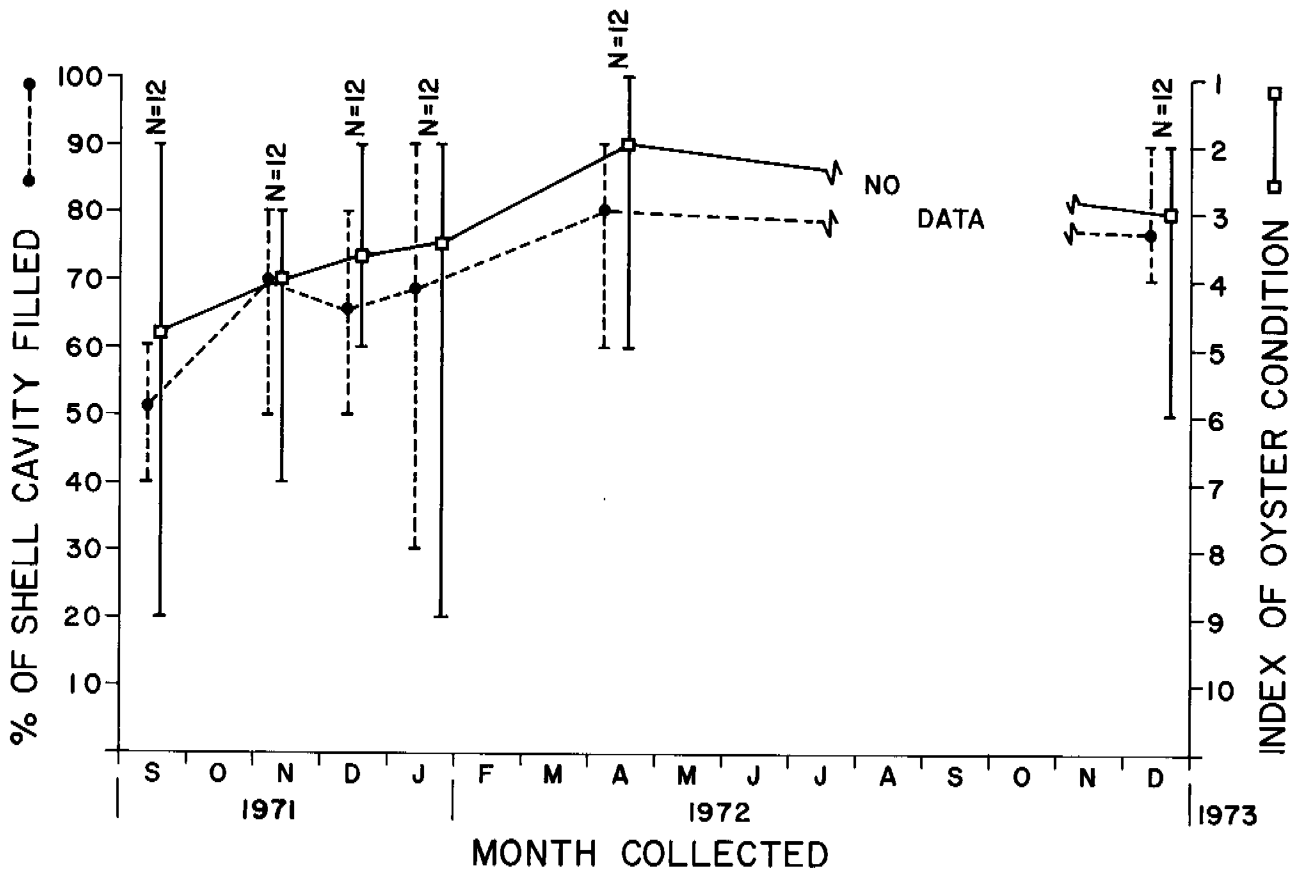

Figure 26. Meat size and condition of East Bay oysters.

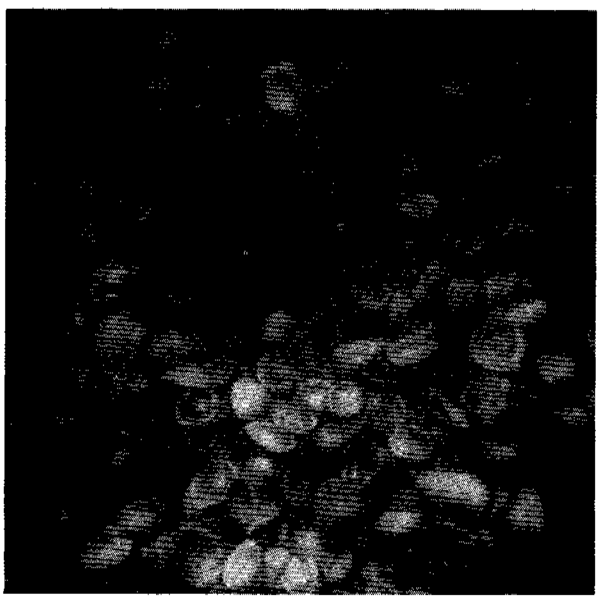

Figure 27. Underwater photograph of siltation on clam shell planted 9/16/72 at Site D.

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APPENDIX I. SEQUENTIAL LISTING OF SUBSTRATE SAMPLING STATIONS, PENSACOLA ESTUARY

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
10-19-71	S-1	30°28′25″ 87°05′58″	2.7	Silty mud & shell frag.	Some eroded shell hash beneath mud
10-19-71	S-2	30°38′26″ 87°05′56″	2.5	Silty mud	Occasional mussels and worm tubes on exposed shell fragments
10-19-71	S-3	30°28′26″ 87°05′54″	1.0	Firm sand	Firm coarse sand, devoid of marine grasses or algae approximately 200 m of East shore, Escambia Bay
10-19-71	S-4	30°28′27″ 87°05′55″	1.0	Sandy mud	Barren of shell and vegetation
10-19-71	S-5	30°28′ 27″ 87°05′58″	2.7	Silty mud	
10-19-71	S-6	30°28′27″ 87°05′57″	1.8	Firm sandy mud	
10-19-71	S-7	30°28′28″ 87°05′59″	3.0	Silty mud & shell frag.	Mud dark colored but did not give off H_2S smell
10-22-71	S-8	30°28′18″ 87°05′54″	1.2	Firm sand	
10-22-71	S-9	30°28′18″ 87°05′52″	1.0	Firm sand	Area barren of shell or vegetation, dredge haul empty
10-22-71	S-10	30°28′36″ 87°05′54″	1.8	Firm sand mud	
10-22-71	S-11	30°28′12″ 87°05′54″	1.8	Firm sandy mud	
10-22-71	S-12	30°28′12″ 87°06′00″	1.9	Sandy mud	No shell fragments evident
10-22-71	S-13	30°28′12″ 87°06′06″	2.4	Firm sandy mud	Potentially good oyster planting area
10-22-71	S-14	30°28′18″ 87°06′06″	2.1	Sandy mud	Scattered shell fragments above and beneath mud
10-23-71	S-15	30°26′00″ 87°05′18″	1.5	Firm sand	Sandy shelf SE of Garcon Pt. barren of shell and submerged vegetation
10-23-71	S-16	30°26′18″ 87°05′06″	1.2	Firm sand	Inshore shelf barren of oysters and submerged vegetation
10-23-71	S-17	30°26′24″ 87°03′06″	2.1	Soft silty mud	Soft mud throughout area peripheral to White Pt. oyster reef
10-24-71	S-18	30°28′48″ 87°09′18″	2.1	Mud and shell hash	Possibly an extinct oyster reef
10-24-71	S-19	30°28′54″ 87°09′00″	2.4	Soft silty mud	Region of soft sediments, blackened shell fragments
10-24-71	S-20	30°28′54″ 87°08′54″	2.4	Soft silty mud	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
10-24-71	S-21	30°28′54″ 87°08′48″	2.4	Soft silty mud	
10-24-71	S-22	30°28′48″ 87°08′42″	2.4	Soft silty mud	
10-24-71	S-23	30°28′54″ 87°08′42″	2.4	Soft silty mud	Muddy area adjacent to "hogback" oyster reef
10-24-71	S-24	30°29′00″ 87°08′42″	2.1	Live oysters & shell frag.	Over peripheral portion of oyster reef
10-24-71	S-25	30°29′00″ 87°08′42″	2.4	Live oysters & shell hash	Additional probing of extent of oyster reef
10-24-71	S-26	30°29′00″ 87°08′36″	2.4	Soft silty mud	Eastern margin of reef, diameter approximately 75 m
10-24-71	S-27	30°29′06″ 87°08′54″	2.7	Soft silty mud & shell hash	
10-24-71	S-28	30°29′06″ 87°09′00″	2.7	Silty mud & shell hash	Shell fragments often blackened by burial in sediments
10-24-71	S-29	30°28′54″ 87°09′06″	2.1	Soft silty mud	
10-24-71	S-30	30°29′00″ 87°08′54″	2.1	Live oysters & shell hash	Surface of reef composed of densely packed shell fragments and scattered oysters
10-29-71	S-31	30°28′00″ 87°05′54″	0.6	Firm sand	Drifted along SE shore of Escambia Bay looking for intertidal oysters in the shallows
10-29-71	S-32	30°27′48″ 87°05′54″	0.7	Firm sand	No oysters evident on debris in shallow water
10-29-71	S-33	30°27′54″ 87°06′00″	0.7	Firm sand	No oysters or vegetation in slightly deeper waters
10-29-71	S-34	30°28′06″ 87°06′12″	2.7	Firm sandy mud	Live oysters and recent blanks scattered on firm sandy mud bottom, potential culture area
10-29-71	S-35	30°28′07″ 87°06′12″	2.7	Firm mud	Oysters less common in deeper water
10-29-71	S-36	30°27′48″ 87°06′12″	2.8	Soft silty mud	Occasional blackened shell fragments found beneath mud
10-29-71	S-37	30°27′36″ 87°06′12″	2.7	Firm grey mud	Shell fragments and occasional market oysters
10-29-71	S-38	30°27′36″ 87°06′00″	2.4	Firm grey sandy mud	Sandy mud and numerous shell fragments indicate good potential for oyster rehabilitation work
10-30-71	S-39	30°33′42″ 87°00′24″	2.4	Firm grey mud	Unable to locate a reef reputed to be in this portion of Blackwater River
10-30-71	S-40	30°26′30″ 86°58′06″	3.0	Firm sandy grey mud	Firm bottom devoid of oysters off southern shore of East Bay
10-30-71	S-41	30°26′24″ 86°58′12″	3.0	Firm mud & live oysters	Oysters (market and sub-market) common

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
10-30-71	S-42	30°26′18″ 86°58′06″	1.5	Firm sand	Inshore area of southern East Bay devoid of oysters and marine vegetation
10-30-71	S-43	30°26′30″ 86°57′48″	2.1	Sandy mud	No oysters to the East or West for approx. 100 m
10-30-71	S-44	30°26′36″ 86°57′48″	2.4	Sandy mud & oysters	Oysters numerous
10-30-71	S-45	30°29′36″ 87°01′18″	2.6	Grey sandy mud, shell fragment	Oysters scattered
10-31-71	S-46	30°34′00″ 87°09′36″	2.4	Very soft silty mud	Bottom of northern portion of Escambia Bay is very soft
10-31-71	S-47	30°33′30″ 87°09′00″	2.7	Fine silty mud	Within 10 m of American Cyanamid Co. outfall
10-31-71	S-48	30°33′00″ 87°08′30″	1.8	Firm grey sandy mud	
10-31-71	S-49	30°33′00″ 87°08′06″	1.8	Firm sandy mud	No shell evident despite firm bottom
10-31-71	S-50	30°32′42″ 87°08′00″	1.8	Sandy mud	Sandy inshore, muddy further out
10-31-71	S-51	30°30′42″ 87°01′06″	1.8	Grey silty mud	Probed for beds reputed to lie NW of Escribano Pt., Blackwater Bay
10-31-71	S-52	30°30′36″ 87°01′12″	2.6	Shell hash under dark silty mud	
10-31-71	S-53	30°30′36″ 87°01′06″	1.8	Shell hash under grey silty mud	No exposed shell or oysters evident
10-31-71	S-54	30°30′18″ 87°01′24″	1.8	Firm coarse sand	
10-31-71	S-55	30°30′18″ 87°01′30″	2.1	Firm sand	
11-03-71	S-56	30°26′24″ 86°56′06″	2.1	Soft silty mud	
11-03-71	S-57	30°26′18″ 86°56′06″	1.8	Soft silty mud	
11-03-71	S-58	30°26′12″ 86°56′00″	1.8	Soft silty mud	
11-03-71	S-59	30°26′06″ 86°56′00″	1.2	Silty mud over shell hash	Densely packed shell fragments indicate that this is an extinct reef
11-04-71	S-60	30°34′48″ 87°00′42″	1.8	Sandy mud and old timbers	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-04-71	S-61	30°34′42″ 87°00′42″	1.6	Soft silty mud	
11-04-71	S-62	30°34′42″ 87°00′36″	1.2	Firm sand	Over sandy inshore shelf
11-04-71	S-63	30°33′54″ 87°00′12″	1.8	Soft sandy mud	
11-04-71	S-64	30°34′36″ 86°59′24″	1.0	Firm sandy mud	
11-04-71	S-65	30°34′18″ 86°59′30″	2.1	Soft silty mud	
11-04-71	S-66	30°34′00″ 86°59′24″	2.1	Soft silty mud	
11-04-71	S-67	30°34′06″ 86°56′36″	1.2	Soft grey mud	
11-04-71	S-68	30°34′00″ 86°59′18″	.9	Sandy mud	
11-06-71	S-69	30°24′30″ 87°05′06″	1.8	Sand	Sandy shelf all along southern shallows of East Bay
11-06-71	S-70	30°24′36″ 87°05′06″	1.6	Firm sand	
11-06-71	S-71	30°24′42″ 87°05′06″	3.6	Firm sandy mud	
11-06-71	S-72	30°24′48″ 87°04′54″	6.6	Unknown	
11-06-71	S-73	30°24′24″ 87°04′54″	2.4	Firm sand	
11-06-71	S-74	30°25′24″ 77°03′00″	4.5	Soft silty mud	
11-06-71	S-75	30°26′24″ 87°02′28″	3.0	Soft grey mud w/fine sand	Too soft for oysters
11-06-71	S-76	30°26′48″ 87°02′30″	2.7	Firm sand mud w/old shell	A good firm substrate for culture but softens as proceed East
11-06-71	S-77	30°26′30″ 87°02′06″	3.6	Fine soft grey mud	Too soft for oysters
11-06-71	S-78	30°26′32″ 87°02′54″	2.7	Fine soft silty mud	Reef at Station II (permanent) is small and doesn't extend too far east
11-06-71	S-79	30°26′42″ 87°02′20″	3.0	Shell frag. & some live oysters	Such shell, but live and market oyster uncommon
11-06-71	S-80	30°26′45″ 87°02′26″	2.7	Soft fine mud	Very soft, no shell, off of reef

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-06-71	S-81	30°26′40″ 87°02′18″	3.0	Old shell to soft mud	Margin of reef, transition from shell to mud
11-07-71	S-82	30°25′17″ 87°11′33″	1-1.8	Sand	Oysters are concentrated within 15 m of L & N Trestle
11-07-71	S-83	30°25′18″ 87°11′34″	3.9	Old shell & sandy mud	The boat channel south of the trestle is deep (3.5 m)
11-07-71	S-84	30°25′19″ 87°11′34″	1.8-3.0	Sand, rock oyster boxes	Most of the oysters here died recently 90% - 100% killed
11-07-71	S-85	30°25′22″ 87°11′28″	interti-dal to .6	Sandy mud, extensive shell	Live oysters very scarce, 90% mort., recent boxes plentiful
11-07-71	S-86	30°25′50″ 87°11′24″	2.4	Soft silty mud w/old shell	Bottom very soft in center of Bayou Texar
11-07-71	S-87	30°25′34″ 87°11′24″	2.4	Soft sticky mud	Soft bottom
11-07-71	S-88	30°25′36″ 87°11′16″	1.5	Firm sand & mud	Just N of Cervantes St. Bridge
11-10-71	S-89	30°25′30″ 87°11′16″	3.9	Firm sand & mud	Under Cervantes St. Bridge
11-10-71	S-90	30°31′57″ 87°08′05″	1.8	Sandy mud	500 m off E shore of Escambia B.
11-10-71	S-91	30°31′42″ 87°07′58″	1.2	Sand w/ traces of mud	The entire area out of 500 m off S shore is sandy
11-10-71	S-92	30°31′12″ 97°07′40″	2.4	Soft sticky grey mud	An area of mud extends down from the I-10 Bridge
11-10-71	S-93	30°31′07″ 87°07′13″	2.2	Fine soft mud	Bed ends 20 m south of E-25
11-10-71	S-94	30°31′01″ 87°07′20″	2.4	Fine soft mud over od shell hash	A muddy area
11-10-71	S-95	30°30′59″ 87°06′37″	2.4	Fine soft grey mud	No shell, Hinton lease
11-10-71	S-96	30°30′54″ 87°06′35″	2.4	Soft mud	Hinton lease
11-10-71	S-97	30°30′50″ 87°06′32″	2.4	Fine soft mud over old shell	Middle of Todd Lease
11-11-71	S-98	30°28′12″ 87°06′10″	1.2 to inter tidal	Firm coarse sand	Poled inshore looking for intertidal oysters, but area was barren
11-11-71	S-99	30°30′00″ 87°06′30″	2.4	Shell hash	Pearson's large lease, foulers and boxes scarce

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-11-71	S-100	30°29'22" 87°06'24"	2.4	Sandy mud shell hash recent boxes	An area of many blanks, once a large bed, some spat in blanks
11-11-71	S-101	30°29'14" 87°06'56"	3.0	Soft fine grey mud	Far offshore, muddy area
11-11-71	S-102	30°29'23" 87°07'23"	3.0	Soft fine grey mud	
11-13-71	S-103	30°27'32" 87°09'26"	1.2	Sand, transition to soft mud	
11-13-71	S-104	30°27'42" 87°09'22"	1.2-1.5	Sandy mud, sand to shoreward	Sand inshore, drops rapidly into mud offshore
11-13-71	S-105	30°27'40" 87°09'06"	3.0	Soft sticky fine grey mud	About 700 m off W shore
11-13-71	S-106	30°27'38" 87°09'30"	3.0	Soft fine grey mud	
11-13-71	S-107	30°27'38" 87°09'33"	1.0	Coarse yellow sand	200 m off W shore, Escambia Bay
11-13-71	S-108	30°27'39" 87°09'27"	3.0	Soft fine grey mud	
11-13-71	S-109	30°27'40" 87°09'30"	3.3	Soft grey mud	
11-13-71	S-110	30°27'42' 87°09'32"	2.7	Oysters, shell, silt	Sharp drop, off inshore, 4 m
11-13-71	S-111	30°27'42" 87°09'31"	3.0	Soft fine mud	
11-13-71	S-112	30°27'48" 87°09'25"	2.4	Shell and mud	
11-13-71	S-113	30°27'45" 87°09'26"	2.7	Soft fine grey mud	Probing shows bed ends 100 m N and is long and narrow
11-13-71	S-114	30°27'58" 87°09'31"	1.2	Coarse yellow sand	
11-13-71	S-115	30°27'58" 87°09'29"	1.2	Coarse sand	
11-13-71	S-116	30°28'05" 87°09'27"	2.7	Shell and sandy mud	Old shell and mud scattered for 100 m SE of here
11-13-71	S-117	30°28'07" 87°09'24"	2.7	Firm sandy mud	
11-13-71	S-118	30°29'18" 87°09'23"	2.7	Live oysters, shell	Some good live oysters here
11-14-71	S-119	30°28'14" 87°06'20"	3.0	Soft sandy mud	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-14-71	S-120	30°28′32″ 87°06′25″	3.0	Live oysters, shell, soft mud	Occasional live oyster, many recent boxes, mud
11-14-71	S-121	39°29′12″ 87°06′34″	2.7	Live oysters, recent boxes	
11-14-71	S-122	30°29′44″ 87°06′13″	2.4	Live oysters, recent boxes, mud	Northern border of Pearson's small lease, spat plentiful
11-14-71	S-123	30°29′58″ 87°06′28″	2.7	Live oysters recent boxes mud	Public bed S of Pearsons
11-14-71	S-124	30°29′58″ 87°06′42″	2.7	Live oysters boxes mud	About 20 m W of Pearson's large lease
11-14-71	S-125	30°29′50″ 87°06′50″	2.4	Recent boxes & shell	Many spat, 2 mo. old in boxes
11-14-71	S-126	30°28′36″ 87°06′28″	3.3	Soft fine grey mud	
11-14-71	S-127	30°26′45″ 87°10′03″	3.6	Soft fine grey mud	
11-14-71	S-128	30°26′45″ 87°10′06″	2.1	Coarse light sand	
11-18-71	S-129	30°30′36″ 87°00′44″	2.1	Firm sandy mud	Two hundred m off E. shore, Blackwater R.
11-18-71	S-130	30°30′32″ 87°00′37″	.6	Firm coarse yellow sand	Just 15 m from East shore
11-18-71	S-131	30°30′37″ 87°00′37″	1.4	Firm sandy mud	
11-18-71	S-132	30°30′35″ 87°00′43″	2.0	Soft sandy mud	
11-18-71	S-133	30°30′35″ 87°00′47″	2.0	Firm sandy mud	
11-18-71	S-134	30°30′34″ 87°00′50″	2.0	Grey mud over old shell	
11-18-71	S-135	30°30′37″ 87°00′29″	2.1	Soft mud over firm mud & shell	
11-18-71	S-136	30°30′38″ 87°01′00″	2.0	Sandy mud over shell	
11-18-71	S-137	30°30′30″ 87°01′10″	2.2	Very soft sticky grey mud	Now 500 m offshore
11-18-71	S-138	30°30′34″ 87°01′14″	2.4	Soft grey mud w/some old shell	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-18-71	S-139	30°31′36″ 87°01′14″	2.4	Very soft sticky grey mud, no shell	
11-18-71	S-140	30°30′20″ 87°01′35″	2.7	Live spat, shell, recent blanks	No market oysters, spat abundant.
11-18-71	S-141	30°30′36″ 87°30′30″	2.7	Shell and soft mud	
11-18-71	S-142	30°30′33″ 87°30′28″	2.7	Shell & live oysters	
11-18-71	S-143	30°30′23″ 87°01′34″	2.1	Firm hard sand	
11-18-71	S-144	30°30′24″ 87°01′36″	3.0	Fine soft grey mud	
11-18-71	S-145	39°30′27″ 87°01′38″	3.0	Fine soft grey mud	
11-18-71	S-146	30°30′29″ 87°01′44″	3.0	Fine soft grey mud	
11-18-71	S-147	30°30′30″ 87°01′46″	3.0	Fine soft grey mud	
11-18-71	S-148	30°30′28″ 87°01′24″	1.8	Sand & sandy mud	
11-18-71	S-149	30°30′29″ 87°01′25″	2.7	Grey sandy mud, shell & oysters	
11-18-71	S-150	30°30′44″ 87°01′30″	2.7	Scattered oysters & shell, mud bottom	
11-18-71	S-151	39°30′30″ 87°01′32″	3.0	Silt over scattered oysters & shell	
11-19-71	S-152	30°24′30″ 87°03′35″	3.3	Firm coarse sand	
11-19-71	S-153	30°25′30″ 87°00′00″	3.9	Soft fine grey mud	No oysters
11-19-71	S-154	30°25′34″ 87°00′02″	3.3	Soft mud, shell, and oysters	An area of commercial harvest
11-20-71	S-155	39°26′37″ 87°04′58″	1.0-1.8	Sandy near shore, sandy mud here	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-20-71	S-156	30°26′26″ 87°04′56″	1.8	Firm sandy mud	
11-20-71	S-157	30°26′36″ 87°04′38″	1.8	Firm sandy mud, clusters of oysters	
11-20-71	S-158	30°26′36″ 87°04′37″	1.8	Firm sandy mud with scattered old shell	Between Garcon and White Pts., 300 m offshore
11-20-71	S-159	30°26′49″ 87°04′30″	1.0	Firm sand & mud	Between White and Garcon Pts., 100 m offshore
11-20-71	S-160	30°26′46″ 87°04′18″	1.3	Soft grey sandy mud	No oysters, 100 m offshore
11-20-71	S-161	30°26′49″ 87°04″20″	inter-tidal	Soft sandy mud, "peat"	Young oysters and spat growing thickly on shore and out to 15 m
11-20-71	S-162 (a)	30°26′44″ 87°04″28″	1.8	Fine soft grey mud, scattered clusters of oysters	
11-25-71	S-162 (b)	30°28′36″ 87°06′35″	2.4	Live oysters, old shell, mud	A long bed, was being harvested
11-25-71	S-163	39°28′27″ 87°06′36″	2.7	Very soft fine grey mud	
11-25-71	S-164	30°27′48″ 87°06′01″	2.8	Soft mud shell, live oysters	A small bed, recent boxes
11-25-71	S-165	30°27′33″ 87°06′12″	2.7	Firm grey sandy mud	Good relay area
11-25-71	S-166	30°27′30″ 87°06′10″	2.4	Firm sandy mud	
11-25-71	S-167	39°27′25″ 87°06′18″	2.2	Firm sandy grey mud	
11-25-71	S-168	30°27′20″ 87°06′25″	2.4	Firm sandy grey mud	
11-25-71	S-169	30°27′12″ 87°06′36″	1.8	Coarse yellow sand	
11-25-71	S-170	30°27′06″ 87°06′36″	2.1	Firm sand w/ traces of mud	
11-25-71	S-171	30°27′02″ 87°06′36″	2.7	Firm grey sandy mud	About 1,000 m offshore
11-26-71	S-172	30°32′08″ 87°09′36″	2.7	Very soft grey mud	
11-26-71	S-173	30°32′08″ 87°09′32″	2.1	Soft silty mud	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
11-26-71	S-174	30°31′38″ 87°09′04″	3.0	Soft silty grey mud	An old oyster bed was reported here
11-26-71	S-175	30°31′36″ 87°09′09″	2.7	Fine soft grey mud	Looking for old bed near "14" bouy
11-26-71	S-176	30°31′38″ 87°09′11″	2.7	Very soft grey silt	
11-26-71	S-177	30°31′30″ 87°09′09″	2.7	Old shell fragments	Old bed, mostly under silt
11-27-71	S-178	30°27′22″ 87°03′07″	3.0	Soft fine grey mud	Inshore of this area it is very sandy
11-27-71	S-179	30°27′44″ 87°02′36″	3.3	Fine soft grey mud	
11-27-71	S-180	30°27′40″ 87°02′44″	3.0	Soft grey mud	No oysters 400 m off and to channel
11-27-71	S-181	30°27′28″ 87°02′36″	3.0	Soft grey mud	
11-27-71	S-182	30°27′26″ 87°02′37″	3.0	Soft grey mud	
11-27-71	S-183	30°27′23″ 87°03′12″	2.8	Soft grey mud	Very muddy from channel to here
11-27-71	S-184	30°27′00″ 87°02′30″	3.1	Soft fine grey mud	
11-30-71	S-185	30°26′19″ 87°03′04″	2.7	Soft grey mud	
11-30-71	S-186	30°26′18″ 87°03′02″	2.5	Soft mud	
11-30-71	S-187	30°26′30″ 87°03′05″	2.7	Soft grey mud	
11-30-71	S-188	30°26′18″ 87°02′54″	2.4	Soft grey mud	
11-30-71	S-189	30°26′18″ 30°03′09″	3.0	Old shell hash	
12-04-71	S-190	30°31′52″ 87°01′18″	2.7	Old shell under soft grey mud	Some exposed shell w/spat to the SE, but no market oysters
12-04-71	S-191	30°31′22″ 87°01′34″	2.7	Soft dark silty mud	
12-04-71	S-192	30°31′18″ 87°01′38″	3.0	Very soft silty mud	
12-04-71	S-193	30°31′16″ 87°01′36″	2.7	Old shell hash mud	
12-04-71	S-194	30°31′12″ 87°01′36″	2.7	Scattered shell under mud	Shell is much scarcer here

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
12-04-71	S-195	30°31'36" 87°07'20"	2.4	Soft grey mud over shell	
12-04-71	S-196	30°31'37" 87°01'23"	2.4	Soft grey mud over shell	
12-04-71	S-197	30°31'12" 87°01'40"	2.4	Soft mud & shell	About 50 m S of "20" day marker
12-04-71	S-198	30°31'11" 87°01'36"	2.7	Scattered shell old valves	Former bed, spat common, no market oysters
12-09-71	S-199	30°29'44" 87°01'38"	2.7	Live oysters, shell	Part of an extensive commercial area
12-09-71	S-200	30°20'40" 87°01'34"	2.1	Live oysters, shell	
12-09-71	S-201	30°29'38" 87°01'28"	2.2	Scattered oysters, mud shelf	
12-09-71	S-202	30°29'35" 87°01'24"	2.4	Sandy mud, scattered oysters	It appears that this is an area of reef separated by patches of mud.
12-09-71	S-203	30°27'25" 86°51'41"	2.1	Scattered shell hash & mud	Reef ends here
12-09-71	S-204	30°27'33" 86°57'22"	2.7	Soft mud scattered oyster & shell	Reef is at least 150 m long
12-11-71	S-205	30°28'45" 87°06'33"	3.3	Shell, mud oysters	Spat common, also small barnacle and foulers
12-12-71	S-206	30°29'10" 87°08'03"	3.3	Very soft grey mud	About 300 m S of "7" light
12-12-71	S-207	30°29'12" 87°08'03"	3.3	Soft grey mud w/ scattered shell fragments	
12-12-71	S-208	30°29'15" 87°08'01"	3.3	Soft grey mud	
12-12-71	S-209	30°29'17" 87°08'02"	3.9	Soft grey mud	In the ship channel
12-12-71	S-210	30°29'16" 87°08'05"	3.0	Soft grey mud	
12-12-71	S-211	30°29'17" 87°08'05"	3.0	Soft grey mud w/ scattered shell fragment	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
12-12-71	S-212	30°29′18″ 87°08′05″	2.1	Dense shell, oysters, spat	Reef begins here, 20 m from "7" light.
12-12-71	S-213	30°29′20″ 87°08′03″	3.3	Shell, oysters, soft grey mud	Transition, shell mound to mud basin
12-12-71	S-214	30°29′25″ 87°08′04″	3.9	Soft grey mud w/ scattered shell fragment	In the ship channel
12-12-71	S-215	30°29′06″ 87°08′01″	3.0	Soft grey mud	
12-12-71	S-216	30°29′16″ 87°08′02″	3.0	Dense shell hash	Spat abundant
12-12-71	S-217	30°29′18″ 87°08′03″	3.0	Dense oysters and shell	Many market oysters 70-90 mm, about 20 m E of "7"
12-12-71	S-218	30°29′17″ 87°08′04″	2.4	Dense oysters and shell	About 10 m S of "7" light, on top of shell mound
12-12-71	S-219	30°20′18″ 87°08′03″	2.4	Oysters & shell	Much of the shell is "barren"; Some recent spat
12-12-71	S-220	30°29′37″ 87°08′25″	2.7	Soft grey mud w/ scattered shell fragment	
12-12-71	S-221	30°29′45″ 87°08′24″	2.7	Soft grey mud	
12-12-71	S-222	30°29′50″ 87°08′45″	2.7	Soft sticky grey mud	A very muddy area
12-12-71	S-223	30°29′46″ 87°08′59″	2.4	Soft mud	No oysters from intertidal to here (NE drift)
12-16-71	S-224	30°25′42″ 87°11′20″	2.1	Scattered oysters	Oysters more common N of #54
12-16-71	S-225	30°25′48″ 87°11′20″	2.7	Very soft grey mud	
12-16-71	S-226	30°25′40″ 87°11′18″	2.1	Sandy grey mud, shell & oysters	Several market oysters
12-16-71	S-227	30°25′44″ 87°11′20″	1.5	Sand, grey mud, oysters	Oysters grow in clusters along the transition zones. Zone has much detritus.
12-16-71	S-228	30°25′46″ 87°11′18″	2.1	Sandy mud, oysters & shell	About 40 m offshore.
12-16-71	S-229	30°25′49″ 87°11′15″	2.1	Soft grey mud	
12-16-71	S-230	20°25′48″ 87°11′15″	1.5	Sandy mud, oysters & shell	Boxes and detritus abundant near shore

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
12-16-71	S-231	30°25′50″ 87°11′11″	1.8	Sandy mud inshore, silty mud offshore	Oysters & shells in zone where sandy mud turns to silt
12-16-71	S-232	30°25′52″ 87°11′11″	2.1	Oysters & shell, sandy mud	Oysters growing in clusters, extensive silting.
12-16-71	S-233	30°25′53″ 87°11′08″	2.5	Soft grey mud	About 100 m off E shore, Bayou Texar
12-16-71	S-234	30°25′52″ 87°11′06″	2.1	Oysters & shell, sandy mud	Much sand and detritus near (300 m) shore
12-16-71	S-235	30°26′09″ 30°11′01″	2.7	Sandy mud inshore, silt offshore, oysters between	Oysters partially buried in silt, fouling light
12-16-71	S-236	30°26′26″ 30°11′14″	2.1	Soft grey mud, shell & oysters	Extensive "bed" of scattered clusters of oysters, growing amidst detritus
12-16-71	S-237	30°26′00″ 87°11′12″	1.6	Oysters & shell scattered over sandy mud	
12-18-71	S-238	30°26′20″ 87°11′20″	1.2	Oysters on sand and grey mud	Oysters in scattered clusters
12-18-71	S-239	30°26′50″ 87°11′20″	1.2 to .6	Soft mud offshore, sandy inshore	Scattered seed oyster on intertidal rocks, some old shell here
12-18-71	S-240	30°26′48″ 87°11′18″	1.2 to .6	Mud & sand	
12-18-71	S-241	30°26′48″ 87°11′13″	1.8	Soft grey mud, but sandy inshore	Old shell under mud
12-18-71	S-242	30°26′45″ 87°11′08″	1.8	Soft grey mud, shell	About 30-40 m off E shore of Bayou Texar
12-18-71	S-243	30°26′40″ 87°11′08″	2.4	Soft grey mud	
12-18-71	S-244	30°26′36″ 87°11′18″	1.6	Sandy mud, shell & oysters	Several scattered large oysters in the transition zone
12-18-71	S-245	30°26′28″ 87°11′15″	1.2	Sand & soft mud	Scattered shell & oysters to the S, 10 m out and to shore

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
12-18-71	S-246	30°26′27″ 87°11′15″	1.2	Oysters & shell, sandy mud & detritus	Fine large oyster here, spat scarce
12-18-71	S-247	30°26′14″ 87°11′18″	1.8	Oysters & shell scattered in sand & mud	
12-21-71	S-254	30°28′47″ 87°09′41″	1.2	Old shell, sandy mud	Bottom sandy near shore
12-21-71	S-255	30°28′33″ 87°09′20″	2.1	Firm coarse sand	At the N.E.S.T.P. outfall
12-21-71	S-256	30°27′06″ 87°10′06″	1.2 to 1.8	Sand & soft mud	Transition zone is very abrupt, no oysters.
12-22-71	S-257	30°26′11″ 87°00′48″	3.3	Oysters & many boxes	Edge of bed, steep drop to mud basin
12-22-71	S-258	30°26′12″ 87°00′48″	4.2	Soft grey mud w/shell frag.	
12-22-71	S-259	30°26′00″ 87°00′40″	2.1	Small oysters, old shell hash	Large oysters scarce in center of bed
12-22-71	S-260	30°26′01″ 87°00′40″	2.1	Mostly old shell	Moved W→E across bed. At E margin found shell frag. and soft mud
12-27-71	S-261	30°26′24″ 87°03′01″	3.0	Shell hash, oysters	Bed runs W 150 m, good oystering at periphery
12-27-71	S-262	30°26′28″ 87°02′30″	3.0	Shell hash, oysters	Oysters small and scarce, but bed is worked commercially
12-27-71	S-263	30°28′16″ 87°06′42″	3.0	Soft mud, shell hash, boxes	Extensive long bed of oysters, 1500 m offshore, spat abundant
12-30-71	S-264	30°21′31″ 87°00′50″	2.1	Firm grey sand	
12-30-71	S-265	30°21′29″ 87°00′51″	1.5	Scattered clusters of oysters on sand	Spat, foulers and algae abundant, oysters small
12-30-71	S-266	30°21′14″ 87°00′54″	1.5	Cluster oysters on sand	
12-30-71	S-267	30°21′44″ 87°01′06″	1.5	Sand, grass, scattered boxes	Tidal current runs E, 1-2 kt
12-30-71	S-268	30°21′37″ 87°01′06″	1.8	Barren sand	Seems to be a barren "gully" here

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
12-30-71	S-269	30°21'36" 87°01'07"	2.1	Grey sand	No shell, deep
12-30-71	S-270	30°21'31" 87°01'11"	1.5	Barren grey sand	
12-30-71	S-271	30°21'32" 87°01'10"	1.2	Grey sand & grass	
12-30-71	S-272	30°21'30" 87°01'10"	2.1	Sand & grass	
12-30-71	S-273	30°21'40" 87°01'04"	1.2	Cluster oysters & sand	Up on sand bar now. Oysters small but with good growth
12-30-71	S-274	31°21'53" 87°01'05"	1.8	Sand, grass, cluster oysters	No market oysters here, mostly boxes and spat
12-30-71	S-275	31°21'32" 87°01'05"	1.0	Sand, grass	Many larger oysters found between 400 and 100 yds off S shore of Sound
12-30-71	S-276	31°21'36" 87°01'02"	1.2	Sand & grass	
12-30-71	S-277	31°21'37" 87°00'57"	1.5	Sand, grass cluster oysters	Clusters of submarket & small oysters common, 20% mortality
12-30-71	S-278	31°21'40" 87°00'56"	1.5	Sand and cluster osyters	
12-30-71	S-279	31°21'41" 87°00'57"	1.8	Sand & cluster oysters	Oysters small & medium sized, 50% mortality, fouled by algae
12-30-71	S-280	31°22'05" 87°01'06"	2.4	Sand	No sign of oysters in deeper waters
12-30-71	S-281	31°21'52" 87°02'03"	2.4	Sand & cluster oysters	Most of the oysters were boxes, 90% mortality. Spat plentiful
12-31-71	S-282	30°20'14" 87°08'04"	1.2	Barren sand	No oysters on or near P.B.S.T.P. outfall. Many worm burrows
12-31-71	S-283	30°20'15" 87°08'02"	1.5	Barren sand	No osyters at this station nor in the shoreline shallows
12-31-71	S-284	30°20'16" 87°08'00"	1.2 to .6	Barren sand & grass	No oysters or shell in shallows from Sharp Pt. to P.B.S.T.P.
1-07-72	S-285	30°27'20" 86°56'18"	.6	Barren sand	Pocketed w/ worm burrows
1-07-72	S-286	30°27'20" 86°57'30"	2.4	Live oysters, old shell	Marketable oysters are common here
1-07-72	S-287	30°27'18" 86°57'30"	2.7	Soft silty mud	Bed ends here
1-07-72	S-288	30°27'21" 86°57'33"	2.4	Oysters & shell hash	Live oysters common, also found *Thais* eggs on shell

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
1-07-72	S-289	30°27′28″ 86°57′36″	2.7	Soft grey mud	No shell
1-07-72	S-290	30°27′30″ 86°57′30″	2.7	Shell, oysters & soft mud	
1-07-72	S-291	30°27′50″ 86°57′28″	.6	Barren firm sand	Some worm burrows in sand, no vegetation
1-07-72	S-292	30°27′10″ 86°57′42″	3.3	Soft grey mud	
1-07-72	S-293	30°26′58″ 86°57′44″	2.1	Soft grey mud	
1-08-72	S-294	30°31′44″ 86°09′11″	2.7	Scattered shell hash & silt	Found small foulers and one 16 mm spat
1-08-72	S-295	30°31′00″ 87°09′24″	2.4	Soft mud over coarse sand	Between I-10 & L & N R.R. trestle
1-08-72	S-296	30°31′02″ 87°06′24″	2.1	Soft mud over old shell	Hinton lease
1-08-72	S-297	30°30′52″ 87°06′20″	1.8	Soft mud over shell	Todd lease
1-08-72	S-298	30°30′57″ 87°06′15″	2.1	Soft mud w/sand firm clay	Middle of Todd lease
1-08-72	S-299	30°30′56″ 87°06′12″	2.1 to 1.2	Soft mud, sandy mud	Probed inshore areas of Todd, found sandy mud
1-08-72	S-300	30°30′34″ 87°06′17″	2.4	Soft grey mud over scattered old shell	Reynolds lease
1-08-72	S-301	30°30′42″ 87°06′06″	2.4	Exposed shell hash mud	In Monroe lease; found 2 boxes (cultch)
1-08-72	S-302	30°30′53″ 87°06′00″	2.1	Firm sandy mud	Moved inshore from Monroe, good substrate
1-12-72	S-303	30°26′31″ 87°06′40″	2.7	Soft & firm sandy mud	Good substrate
1-12-72	S-304	30°26′30″ 87°06′30″	2.7	Fine firm grey sandy mud	
1-12-72	S-305	30°26′23″ 87°06′20″	3.6	Soft fine grey mud	Soft bottom
1-12-72	S-306	30°26′24″ 87°06′30″	2.7	Soft grey mud	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
1-12-72	S-307	30°26′32″ 87°06′33″	2.7	Grey firm sandy mud	Good substrate
1-21-72	S-308	30°29′43″ 87°07′01″	3.0	Soft grey mud w/shell frag.	Shell mound ends 50 yds SE of E-79
1-21-72	S-309	30°29′48″ 87°07′00″	2.7 to 2.1	Soft mud, shell frag. & shell hash	Northern margin of bed, along "wall" of shell mound
1-21-72	S-310	30°29′46″ 87°07′03″	2.4	Shell hash	Spat common on shell, good survival
1-21-72	S-311	30°30′18″ 87°06′22″	2.7	Soft fine grey mud, scattered shell frag.	In middle of Metos lease
1-21-72	S-312	30°30′20″ 87°06′12″	2.1	Soft grey mud over shell frag.	In Metos
1-22-72	S-313	30°26′30″ 87°05′29″	.6	Silty, grey mud, oysters and shell	Small osyters in groups on bottom of tidal creek
1-26-72	S-314	30°25′54″ 86°59′14″	3.0 to 2.1	Mud, oysters & shell mound	Commercial bed, few oysters, spat common (fall set)
1-26-72	S-315	30°26′58″ 86°57′58″	2.1	Oysters & shell	Commercial bed
1-26-72	S-316	30°27′35″ 86°57′09″	2.1	Old shell under silt	
1-26-72	S-317	30°27′38″ 86°57′00″	1.8	Firm sandy mud, old shell	
2-26-72	S-318	30°27′44″ 86°57′12″	1.8	Sand over mud, scattered old shell	Some spat on shell
1-26-72	S-319	30°27′48″ 86°56′54″	2.7	Coarse sandy mud	Some scattered old shell
1-26-72	S-320	30°27′50″ 86°56′56″	2.8	Shell under silty mud	Part of an extensive strip of old shell
1-26-72	S-321	30°27′48″ 86°56′50″	7.8	Soft mud	In deeper H_2O
1-26-72	S-322	30°28′08″ 86°88′12″	2.7	Old shell hash, mud	Sandy to 800 yd from shore
1-27-72	S-323	30°28′24″ 86°58′28″	2.4	Firm grey sandy mud	Good relay area

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
1-27-72	S-324	30°28′20″ 86°58′48″	2.7	Fine soft grey mud	
1-27-72	S-325	30°28′46″ 86°58′52″	1.8	Firm sandy grey mud	Scattered clusters of large marketable oysters
1-27-72	S-326	30°28′50″ 86°58′53″	1.2	Firm barren sand	No oysters shoreward of transition zone
1-27-72	S-327	30°28′54″ 86°58′52″	1.6	Sand, grass, scattered oysters	Cluster and single oysters scattered on sand, 150 yd offshore
1-27-72	S-328	30°28′50″ 86°59′02″	2.1	Grey sandy mud, oysters	
2-05-72	S-329	30°27′52″ 87°09′30″	2.4	Old shell under mud, also live oysters	
2-09-72	S-330	30°28′52″ 87°05′54″	2.4	Oysters, shell boxes, sandy mud	Fine large oysters in clusters
2-09-72	S-331	30°28′57″ 87°06′12″	2.4	Oysters & many boxes, mud	Spat abundant in boxes; silt filled boxes
2-09-72	S-332	30°29′04″ 87°06′12″	2.4	Sandy mud, scattered oysters & shell	
2-09-72	S-333	30°29′09″ 87°06′16″	2.4	Firm sand, mud, scattered shell	Good relay area, oysters scarce
2-09-72	S-334	30°29′44″ 87°06′13″	2.7	Live oysters common soft mud	In Pearson's small lease
2-10-72	S-335	30°29′42″ 87°09′37″	2.1	Old shell hash, mud	Shell is blackened
2-10-72	S-336	30°29′38″ 87°09′37″	2.4	Shell hash under silt	
2-10-72	S-337	30°29′40″ 87°09′47″	2.1	Soft mud over shell hash	
2-10-72	S-338	30°29′42″ 87°09′49″	2.7	Old shell under silty mud	
2-10-72	S-339	30°29′28″ 87°09′55″	1.5	Firm coarse sand	
2-10-72	S-340	30°29′21″ 87°09′20″	3.0	Soft grey mud	

Date	Station Number	Lat (N) Long (W)	Depth (m)	Substrate Type	Pertinent Remarks
2-14-72	S-341	30°29′15″ 86°59′46″	2.0	Sandy mud, oysters shell	500 m offshore, scattered cluster oysters common
2-14-72	S-342	30°29′13″ 86°59′54″	2.0	Scattered oysters	
2-14-72	S-343	30°29′22″ 87°01′23″	1.8	Fine soft grey mud	Many oyster beds in the surrounding area
2-23-72	S-344	30°27′24″ 87°03′36″	2.1	Coarse dark sandy mud	Good relay area, sand ends at 200 yd offshore
2-23-72	S-345	30°28′08″ 87°04′35″	2.0	Soft sandy mud	Muddy offshore, no oysters on the sand that ends 150 yd offshore
2-23-72	S-346	30°31′42″ 87°01′36″	2.1	Soft silty mud over shell	
2-23-72	S-347	30°31′52″ 87°01′37″	2.1	Silt over scattered shell	

APPENDIX II. SEQUENTIAL LISTING OF HYDROLOGICAL/ECOLOGICAL SAMPLING STATIONS

Date & Time	Station Number	Lat. (N) Long (W)	Depth (m)	Substrate	Secchi & Color	Salinity (°/oo)	Temp. (°C)	D.O. (ppm)	pH
10-19-71 1430	H-1	30°28′10″ 87°06′00″	2.7	Silty mud & shell	90 cm brown	24.0 (S) 29.0 (B)	25.0 (S) 25.0 (B)	6.6 (S)	7.0
10-22-71 1430	H-2	30°28′08″ 87°06′03″	2.1	Sandy mud & shell	80 cm brown	24.0 (S) 25.8 (B)	25.5 (S) 25.3 (B)	7.2 (S) 5.6 (B)	9.0
10-23-71 1230	H-3	30°25′05″ 87°05′18″	2.1	Sandy mud	120 cm green	22.5 (S) 24.1 (B)	25.9 (S) 25.4 (B)	6.5 (S) 5.4 (B)	8.0
10-24-71 1530	H-4	30°26′24″ 87°03′06″	2.5	Oysters & shell	130 cm green	21.2 (S) 28.1 (B)	25.3 (S) 26.0 (B)	6.3 (S) 6.5 (B)	8.5
10-24-71 1300	H-5	30°28′48″ 87°09′12″	2.1	Silty mud	N.A.	23.0 (S) 25.9 (B)	25.2 (S) 26.0 (B)	6.3 (S) 6.1 (B)	8.0
10-24-71 1440	H-6	30°28′48″ 87°08′42″	2.4	Silty mud	80 cm brown	23.8 (S) 26.2 (B)	25.3 (S) 25.6 (B)	6.2 (S) 4.3 (B)	7.5
10-24-71 1545	H-7	30°29′00″ 87°08′48″	2.1	Oysters & shell frag.	80 cm brown	23.8 (S) 25.8 (B)	25.6 (S) 25.6 (B)	6.6 (S) 5.6 (B)	8.0
10-29-71 1132	H-8	30°28′00″ 87°06′00″	1.0	Mud & firm sand	to bottom	28.2 (S) 30.1 (B)	25.3 (S) 25.5 (B)	4.8 (S) 3.9 (B)	6.7
10-29-71 1340	H-9	30°28′12″ 87°06′12″	2.5	Sandy mud, shell, & oysters	90 cm brown	30.0 (S) 30.1 (B)	25.5 (S) 25.0 (B)	5.0 (S) 3.1 (B)	7.9
10-29-71 1520	H-10	30°27′54″ 87°06′18″	2.8	Silty mud	90 cm brown	30.0 (S) 31.0 (B)	25.5 (S) 25.0 (B)	4.8 (S) 3.4 (B)	7.8
10-30-71 1420	H-11	30°26′42″ 86°57′30″	1.3	Sand & mud	90 cm brown	25.1 (S) 25.1 (B)	24.2 (B) 24.2 (S)	6.8 (S) 6.0 (B)	6.7
10-30-71 1510	H-12	30°26′24″ 86°58′06″	2.5	Sandy mud, shell & oysters	100 cm brown	24.5 (S) 30.0 (B)	24.4 (S) 25.0 (B)	6.9 (S) 2.4 (B)	7.5
10-31-71 1220	H-13	30°34′00″ 87°97′42″	2.4	Silty mud	70 cm brown	22.0 (S) 23.8 (B)	24.6 (S) 24.3 (B)	7.2 (S) 3.0 (B)	7.2
10-31-71 1600	H-14	30°30′18″ 87°01′19″	1.5	Sand	100 cm brown	20.0 (S) 25.1 (B)	24.6 (S) 24.2 (B)	7.0 (S) 6.0 (B)	8.1
11-03-71 1600	H-15	30°26′24″ 86°56′06″	2.2	Sandy mud shell frag.	60 cm brown	28.0 (S) 27.9 (B)	25.0 (S) 25.2 (B)	6.0 (S) 5.8 (B)	7.9
11-04-71 1200	H-16	30°35′06″ 87°00′48″	3.9	Sandy mud	130 cm green	8.5 (S) 16.1 (B)	22.5 (S) 23.0 (B)	5.8 (S) 4.3 (B)	7.2
11-04-71 1300	H-17	30°34′48″ 87°00′42″	2.4	Sandy mud, silt	112 cm brown	10.2 (S) 12.0 (B)	22.0 (S) 22.4 (B)	6.6 (S) 5.8 (B)	7.7
11-04-71 1445	H-18	30°34′06″ 86°59′42″	2.1	Silty mud	100 cm brown	12.0 (S) 15.7 (B)	21.5 (S) 22.2 (B)	7.4 (S) 6.3 (B)	7.9
11-04-71 1600	H-19	30°35′42″ 87°10′00″	3.9	Firm sandy mud	90 cm brown	10.4 (S) 13.0 (B)	22.0 (S) 22.3 (B)	7.1 (S) 6.2 (B)	8.2
11-06-71 1145	H-20	30°24′18″ 87°05′00″	1.9	Sand	90 cm green	26.0 (S) 27.0 (B)	19.5 (S) 19.7 (B)	8.2 (S) 7.6 (B)	7.6

Date & Time	Station Number	Lat. (N) Long (W)	Depth (m)	Substrate	Secchi & Color	Salinity (‰)	Temp. (°C)	D.O. (ppm)	pH
11-06-71 1230	H-21	30°24′42″ 87°05′06″	6.6	Unknown	90 cm green	26.6 (S) 27.5 (B)	19.5 (S) 19.7 (B)	7.2 (S) 8.6 (B)	7.7
11-06-71 1430	H-22	30°26′30″ 87°03′03″	2.1	Oysters & shell frag.	100 cm brown	20.6 (S) 25.0 (B)	18.7 (S) 19.2 (B)	6.8 (S) 9.2 (B)	7.9
11-07-71 1340	H-23	30°25′18″ 87°11′33″	1.2	Oysters & shell	75 cm	25.2 (S) 25.0 (B)	21.0 (S) 21.0 (B)	7.0 (S) 7.0 (B)	8.8
11-10-71 1200	H-24	30°31′22″ 87°07′25″	2.4	Silty mud	120 cm brown	26.5 (S) 27.0 (B)	15.7 (S) 15.8 (B)	8.1 (S) 8.3 (B)	8.2
11-10-71 1230	H-25	30°31′08″ 87°07′13″	2.1	Sandy mud & shell frag.	120 cm brown	26.0 (S) 26.5 (B)	15.8 (S) 15.8 (B)	8.1 (S) 8.2 (B)	8.3
11-10-71 1350	H-26	30°31′00″ 87°07′20″	2.4	Silty mud	120 cm brown	27.0 (S) 26.0 (B)	15.9 (S) 15.9 (B)	8.0 (S) 8.2 (B)	8.1
11-11-71 1040	H-27	30°28′12″ 87°06′13″	2.4	Sandy mud & shell frag.	150 cm green	26.0 (S) 28.0 (B)	16.2 (S) 17.7 (B)	7.8 (S) 5.8 (B)	7.5
11-11-71 1230	H-28	30°29′36″ 87°06′12″	2.1	Sandy mud & shell frag.	160 cm green	27.0 (S) 27.7 (B)	17.0 (S) 17.5 (B)	8.2 (S) 8.3 (B)	7.9
11-11-71 1345	H-29	30°29′19″ 87°06′28″	2.1	Oysters, shell sandy mud	150 cm	24.5 (S) 29.0 (B)	17.5 (S) 18.2 (B)	9.0 (S) 8.4 (B)	7.5
11-11-71 1500	H-30	30°28′58″ 87°08′48″	2.1	Silty mud, & oysters	130 cm greenish	26.5 (S) 27.8 (B)	17.0 (S) 18.0 (B)	7.8 (S) 7.8 (B)	8.0
11-11-71 1600	H-31	30°28′15″ 87°09′19″	2.7	Sandy mud, oysters, shell,	130 cm	17.6 (S) 28.0 (B)	16.5 (S) 18.0 (B)	8.0 (S) 7.2 (B)	8.6
11-13-71 1200	H-32	30°27′45″ 87°09′30″	2.4	Oysters & shell	160 cm greenish	20.5 (S) 25.7 (B)	17.0 (S) 18.0 (B)	8.0 (S) 8.1 (B)	6.9
11-14-71 1505	H-33	30°28′36″ 87°06′24″	2.7	Soft sandy mud & shell	150 cm	24.0 (S) 28.0 (B)	19.0 (S) 18.7 (B)	8.5 (S) 7.5 (B)	8.1
11-18-71 1150	H-34	30°30′38″ 87°00′48″	2.1	Silty mud shell	130 cm green	24.3 (S) 24.3 (B)	19.7 (S) 19.7 (B)	6.8 (S) 6.8 (B)	7.4
11-19-71 1055	H-35	30°24′34″ 87°05′05″	2.1	Firm sand	160 cm green	28.0 (S) 28.7 (B)	20.0 (S) 20.0 (B)	7.2 (S) 9.0 (B)	8.2
11-19-71 1225	H-36	30°25′33″ 87°00′27″	3.3	Mud & a few oysters	150 cm green	30.0 (S) 30.0 (B)	20.5 (S) 20.4 (B)	7.2 (S) 6.4 (B)	8.0
11-19-71 1100	H-37	30°26′32″ 87°04′59″	2.1	Silty mud & a few oysters	160 cm green	28.0 (S) 30.0 (B)	18.5 (S) 20.0 (B)	6.7 (S) 7.0 (B)	7.4
11-20-71 1400	H-38	30°26′24″ 87°03′30″	2.1	Sandy mud	150 cm green	28.0 (S) 27.5 (B)	19.2 (S) 19.5 (B)	7.2 (S) 7.1 (B)	7.5
11-25-71 1315	H-39	30°28′19″ 87°05′54″	2.5	Sandy mud & oysters	90 cm brownish	27.0 (S) 27.2 (B)	14.0 (S) 14.0 (B)	8.3 (S) 8.2 (B)	8.4
11-26-71 1225	H-40	30°34′07″ 87°09′43″	2.2	Silty mud	110 cm green	13.0 (S) 23.5 (B)	14.8 (S) 14.8 (B)	8.4 (S) 6.6 (B)	8.3

Date & Time	Station Number	Lat. (N) Long (W)	Depth (m)	Substrate	Secchi & Color	Salinity (‰)	Temp. (°C)	D.O. (ppm)	pH
11-26-71 1315	H-41	30°32'28" 87°09'43"	2.4	Silty mud	110 cm green	11.0 (S) 24.2 (B)	15.0 (S) 14.5 (B)	9.1 (S) 8.1 (B)	7.7
11-26-71 1445	H-42	30°31'46" 87°09'14"	2.4	Shell under silty mud	120 cm green	13.0 (S); 27.0 (B)	14.4 (S) 15.5 (B)	9.2 (S) 8.4 (B)	7.9
11-27-71 1550	H-43	30°26'24" 86°58'06"	3.0	Silty mud, oysters	130 cm green	24.0 (S) 25.0 (B)	16.0 (S) 15.5 (B)	8.5 (S) 7.0 (B)	7.9
11-30-71 1510	H-44	30°26'24" 87°03'06"	3.1	Sandy mud oysters	120 cm green	23.0 (S) 26.0 (B)	15.0 (S) 15.4 (B)	7.6 (S) 7.2 (B)	7.9
12-04-71 1320	H-45	30°31'24" 87°01'36"	2.4	Mud, shell, & oysters	110 cm greenish	6.0 (S) 19.5 (B)	11.5 (S) 12.3 (B)	8.5 (S) 7.4 (B)	6.8
12-04-71 1530	H-46	30°29'10" 87°01'17"	2.2	Shell frag. & oysters	N.T.	24.0 (S) 24.0 (B)	12.4 (S) 12.4 (B)	7.8 (S) 7.8 (B)	7.9
12-05-71 1330	H-47	30°25'08" 87°11'30"	inter-tidal	Seawall	to bottom	20.0 (S) N.T.	12.5 (S) N.T.	N.T. N.T.	N.T. N.T.
12-05-71 1400	H-48	30°25'14" 87°11'30"	inter-tidal	Shell & oysters	exposed area	N.T. N.T.	N.T. N.T.	N.T. N.T.	N.T.
12-05-71 1430	H-49	30°25'22" 87°11'31"	0.3	Shell & oysters	to bottom	19.5 (S) N.T.	12.3 (S) N.T.	9.0 (S) N.T.	8.1
12-05-71 1515	H-50	30°25'22" 87°11'18"	inter-tidal	Shell & oysters	30 cm	20.0 (S) N.T.	12.2 (S) N.T.	8.8 (S) N.T.	8.1
12-09-71 1250	H-51	30°29'18" 87°00'44"	2.4	Mud, shell, & oysters	150 cm brown	21.5 (S) 22.0 (B)	17.0 (S) 16.8 (B)	8.4 (S) 8.4 (B)	8.4
12-09-71 1450	H-52	30°27'34" 86°57'34"	2.1	Shell frag. & oysters	125 cm brown	22.6 (S) 23.6 (B)	17.8 (S) 23.6 (B)	6.8 (S) 7.0 (B)	8.7
12-12-71 1135	H-53	30°29'19" 87°08'06"	1.8	Shell frag. & oysters	150 cm brown	06.4 (S) 18.3 (B)	20.3 (S) 18.0 (B)	8.4 (S) 6.8 (B)	7.9
12-16-71 1225	H-54	30°25'44" 87°11'21"	1.8	Mud, shell, & a few oysters	120 cm	14.0 (S) 17.2 (B)	23.0 (S) 21.5 (B)	7.2 (S) 6.6 (B)	8.2
12-16-71 1515	H-55	30°26'07" 87°11'00"	2.1	Mud, shell, & oysters	150 cm green	14.0 (S) 17.2 (B)	23.0 (S) 21.3 (B)	7.2 (S) 5.8 (B)	8.2
12-18-71 1050	H-56	30°27'14" 87°12'12"	1.2	Silty mud m	70 cm brown	11.8 (S) 16.1 (B)	20.0 (S) 21.0 (B)	5.4 (S) 4.9 (B)	8.4
12-18-71 1310	H-57	30°26'44" 87°11'16"	1.8	Mud & sandy mud	100 cm green	15.8 (S) 18.3 (B)	19.0 (S) 19.8 (B)	6.8 (S) 6.4 (B)	8.6
12-18-71 1500	H-58	30°26'12" 87°11'16"	1.8	Silty mud, oysters	120 cm brown	15.0 (S) 17.2 (B)	18.0 (S) 19.0 (B)	7.2 (S) 6.4 (B)	8.5
12-21-71 1215	H-59	30°28'24" 87°05'56"	2.5	Silty mud, shell, oysters	120 cm brown	06.4 (S) 22.6 (B)	20.0 (S) 17.0 (B)	9.4 (S) 8.0 (B)	7.6
12-21-71 1425	H-60	30°29'03" 87°09'47"	2.4	Silty mud, oysters	140 cm	10.7 (S) 19.3 (B)	19.5 (S) 17.5 (B)	8.2 (S) 9.8 (B)	8.2

Date & Time	Station Number	Lat. (N) Long (W)	Depth (m)	Substrate	Secchi & Color	Salinity (‰)	Temp. (°C)	D.O. (ppm)	pH
12-22-71 1145	H-61	30°24′41″ 87°05′06′	2.1	Sand	130 cm brown	16.1 (S) 18.8 (B)	18.0 (S) 18.0 (B)	8.0 (S) 8.6 (B)	8.4
12-22-71 1300	H-62	30°26′03″ 87°00′38″	2.1	Oysters & shell	150 cm green	19.3 (S) 19.1 (B)	19.0 (S) 18.5 (B)	9.6 (S) 10.2 (B)	8.7
12-22-71 1045	H-63	38°26′26″ 86°58′08″	2.4	Shell & oysters	120 cm green	18.8 (S) 24.2 (B)	19.2 (S) 18.5 (B)	7.4 (S) 5.4 (B)	7.8
12-27-71 1245	H-64	30°26′24″ 87°02′58″	2.7	Shell frag. oysters	160 cm green	14.0 (S) 25.3 (B)	19.0 (S) 17.5 (B)	8.0 (S) 5.0 (B)	7.5
12-27-71 1520	H-65	30°34′06″ 87°09′37″	2.7	Silty mud	45 cm brown	01.0 (S) 19.2 (B)	18.0 (S) 17.0 (B)	7.4 (S) 4.0 (B)	7.3
12-30-71 1020	H-66	30°21′24″ 87°01′12″	1.5	Sand, shell oysters	130 cm green	23.6 (S) 23.6 (B)	19.0 (S) 18.7 (B)	7.6 (S) 7.2 (B)	7.2
12-30-71 1300	H-67	31°21′42″ 87°01′06″	1.3	Sand & oysters	120 cm green	24.7 (S) 24.7 (B)	19.5 (S) 19.6 (B)	7.8 (S) 7.6 (B)	7.5
12-31-71 1230	H-68	30°21′24″ 87°08′50″	3.0	Sand	200 cm green	23.6 (S) 23.6 (B)	20.0 (S) 19.0 (B)	7.6 (S) 7.8 (B)	7.5
12-31-71 1250	H-69	30°21′04″ 87°08′08″	2.1	Sand	180 cm	22.6 (S) 23.6 (B)	20.0 (S) 19.2 (B)	7.2 (S) 6.8 (B)	7.2
1-07-72 1100	H-70	30°26′30″ 86°53′06″	1.0	Silty mud	70 cm brown	00.0 (S) 11.8 (B)	14.0 (S) 16.5 (B)	8.6 (S) 8.2 (B)	5.4
1-07-72 1240	H-71	30°27′28″ 86°55′55″	2.7	Silty mud	N.T.	18.3 (S) 20.4 (B)	14.8 (S) 15.6 (B)	8.8 (S) 8.0	5.8
1-07-72 1330	H-72	30°27′25″ 86°57′30″	2.1	Mud, shell, & osyters	120 cm green	20.4 (S) 21.4 (B)	13.5 (S) 13.6 (B)	9.2 (S) 9.0 (B)	5.2
1-07-72 1605	H-73	30°26′54″ 86°57′50″	2.2	Shell frag. oysters	100 cm green	17.7 (S) 18.3 (B)	13.0 (S) 13.1 (B)	9.2 (S) 9.2 (B)	5.5
1-08-72 1310	H-74	30°31′03″ 87°06′26″	2.2	Mud over shell	140 cm brown	19.3 (S) 22.6 (B)	14.5 (S) 16.3 (B)	7.8 (S) 6.4 (B)	6.3
1-08-72 1510	H-75	30°30′56″ 87°06′55″	2.1	Silty mud & shell frag.	90 cm greenish	21.5 (S) 22.0 (B)	16.4 (S) 17.0 (B)	8.8 (S) 7.8 (B)	6.0
1-12-72 1020	H-76	30°24′45″ 87°10′57″	4.8	Firm sandy mud	100 cm brown	7.5 (S) 23.6 (B)	16.4 (S) 17.0 (B)	9.8 (S) 5.8 (B)	6.0
1-12-72 1140	H-77	30°26′31″ 87°06′42″	2.7	Muddy sand	160 cm brown	10.7 (S) 18.3 (B)	17.0 (S) 17.0 (B)	8.6 (S) 8.6 (B)	N.T.
1-12-72 1400	H-78	30°30′24″ 87°09′17″	2.1	Soft sandy mud	100 cm brown	2.1 (S) 15.0 (B)	18.5 (S) 17.0 (B)	9.0 (S) 6.0 (B)	N.T.
1-21-72 1145	H-79	30°29′45″ 87°07′03″	2.1	Shell, spat, oysters	50 cm brown	1.0 (S) 18.3 (B)	15.0 (S) 13.0 (B)	10.0 (S) 6.4 (B)	5.5
1-21-72 1410	H-80	30°30′31″ 87°06′15″	2.7	Silty mud	70 cm brown	1.0 (S) 19.3 (B)	16.2 (S) 13.0 (B)	10.0 (S) 7.0 (B)	7.2
1-22-72 1420	H-81	30°24′24″ 87°05′06″	2.1	Firm sand	90 cm brown	2.1 (S) 18.1 (B)	19.0 (S) 14.0 (B)	10.2 (S) 10.0 (B)	5.5

Date & Time	Station Number	Lat. (N) Long (W)	Depth (m)	Substrate	Secchi & Color	Salinity (0/00)	Temp. (°C)	D.O. (ppm)	pH
1-22-72 1515	H-82	30°26′36″ 87°04′58″	2.1	Soft sandy mud	120 cm brown	6.4 (S) 19.3 (B)	19.4 (S) 14.2 (B)	10.0 (S) 6.8 (B)	6.0
1-26-72 1045	H-83	30°33′58″ 87°09′42″	2.1	Silty mud	50 cm brown	1.0 (S) 15.0 (B)	14.9 (S) 14.5 (B)	8.5 (S) 3.6 (B)	7.8
1-26-72 1220	H-84	30°26′25″ 86°58′19″	2.4	Shell and oysters	120 cm brown	11.8 (S) 21.5 (B)	15.5 (S) 15.0 (B)	9.2 (S) 5.0 (B)	7.2
1-26-72 1405	H-85	30°27′41″ 86°56′50″	2.4	Oysters & shell	140 cm green	11.8 (S) 21.5 (B)	15.0 (S) 15.0 (B)	N.T. N.T.	7.5
1-27-72 1110	H-86	30°26′27″ 87°03′03″	2.5	Oysters & shell	140 cm brown	5.3 (S) 19.3 (B)	16.0 (S) 15.0 (B)	9.2 (S) 4.2 (B)	7.0
1-27-72 1310	H-87	30°28′08″ 86°57′58″	1.0	Firm sand	100 cm +	12.9 (S) 12.9 (B)	17.0 (S) 17.0 (B)	8.4 (S) 8.0 (B)	7.0
1-27-72 1400	H-88	30°28′32″ 86°59′05″	2.4	Shell frag. & oysters	180 cm brown	12.3 (S) 21.5 (B)	16.5 (S) 15.5 (B)	8.2 (S) 3.6 (B)	8.2
2-05-72 1430	H-89	30°29′00″ 87°09′48″	2.7	Shell & oysters	90 cm brown	3.2 (S) 19.3 (B)	10.5 (S) 13.0 (B)	10.4 (S) 9.0 (B)	N.T.
2-06-72 1130	H-90	30°27′14″ 87°05′57″	2.1	Muddy, sand, shell oysters	150 cm brown	12.9 (S) 16.6 (B)	12.0 (S) 11.5 (B)	10.2 (S) 9.0 (B)	6.5
2-09-72 1120	H-91	30°26′12″ 87°05′54″	2.1	Soft sandy mud	110 cm	16.6 (S) 18.3 (B)	12.3 (S) 12.4 (B)	9.0 (S) 8.6 (B)	N.T.
2-09-72 1240	H-92	30°28′09″ 87°05′54″	2.2	Silty mud	150 cm brown	17.2 (S) 21.5 (B)	12.2 (S) 13.0 (B)	10.0 (S) 9.0 (B)	N.T.
2-10-72 1150	H-93	30°27′35″ 87°06′12″	3.0	Firm muddy sand	160 cm green	11.8 (S) 22.0 (B)	12.0 (S) 13.6 (B)	10.0 (S) 7.2 (B)	N.T.
2-14-72 1120	H-94	30°29′00″ 87°59′51″	1.9	Shell under silty mud	130 cm brown	16.1 (S) 17.2 (B)	12.5 (S) 12.0 (B)	10.0 (S) 10.0 (B)	8.0
2-14-72 1330	H-95	30°29′46″ 87.01′10″	2.2	Silty mud & shell	150 cm brown	16.1 (S) 17.0 (B)	12.0 (S) 12.9 (B)	9.1 (S) 9.0 (B)	8.0
2-14-72 1515	H-96	30°29′08″ 87°03′07″	1.1	Muddy sand	90 cm	1.0 (S) 10.0 (B)	12.0 (S) 12.5 (B)	9.2 (S) 9.6 (B)	8.4
2-23-72 1230	H-97	30°27′18″ 87°03′16″	2.7	Muddy sand	150 cm brown	2.0 (S) 8.6 (B)	16.0 (S) 13.5 (B)	10.2 (S) 11.2 (B)	6.5
2-23-72 1450	H-98	30°31′15″ 87°01′41″	2.4	Shell frag. & spat	130 cm brown	3.2 (S) 10.7 (B)	16.5 (S) 13.0 (B)	10.6 (S) 9.0 (B)	6.8