BACTERIOLOGICAL ANALYSIS OF THE NEW RIVER ESTUARY

JACKSONVILLE, NORTH CAROLINA

BY
Gilbert W. Bane
Director, Environmental Studies

and
Catherine C. Roznowski
University of North Carolina at Wilmington

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ABSTRACT

A one year study of the bacteriological quality of the New River Estuary, Jacksonville, North Carolina determined the high coliform levels in the water. The source of these coliforms are predominantly non-human animal origin and from non-point sources. Conclusions result from fecal streptococci to fecal coliform ratios and *Pseudomonas aeruginosa* results. High fecal and total coliform counts were recorded in peripheral sites such as headwaters of the creeks, near the city of Jacksonville and in Wilson Bay. Low fecal and total counts occur in the mid-water sites of Stones and Farnell Bays as a result of high tidal fluxuation and deeper water. The total and fecal coliform counts increased with rain. Coliform pollution is of economic consequence to residents of Onslow County, since approximately 1000 people use the river on the average of once a month and most are involved in recreational fishing or boating.

ACKNOWLEDGMENTS

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SUMMARY AND RECOMMENDATIONS

During a one year study of the bacteriological quality of the New River Estuary, Jacksonville, North Carolina the coliform levels in the water were determined. Testing was performed according to nationally accepted Standard Methods. The source of these coliforms were predominantly from non-human animals that entered the estuary from non-point sources. Conclusions were based upon fecal streptococci to fecal coliform ratios and Pseudomonas aeruginosa results. High fecal and total coliform counts were recorded in peripheral sites, such as headwaters of the creeks, near the city of Jacksonville and in Wilson Bay. Low fecal and total coliform counts were observed in the mid-water sites of Stones and Farnell Bays. These counts were kept in check by high tidal fluxuations and deeper high salinity water. The total and fecal coliform counts increased directly after rainfall. Coliform pollution is of economic importance Onslow County residents. Approximately 1000 people, involved in recreational fishing and boating, use the river on the average of once a month.

Analysis of field and laboratory data collected during this study led to the following conclusions:

1) High total coliform and fecal coliform counts are concentrated around the populated areas of Jacksonville City and in Northeast Creek, Frenchs Creek and in Wilson Bay.
2) Most coliform counts are from non-point sources and are attributed to run-off from agricultural pastures, wildlife, sanitary landfills and storm drains.
3) Fecal streptococci and Pseudomonas aeruginosa data indicate

that most non-point source coliform pollution is of an animal origin.

4) Seasonal distribution patterns of coliform bacteria showed peaks in February, June and August, due to increased rainfall.

5) Increased coliform bacteria will be detrimental to recreational and commercial use of the New River watershed area, as with more coliforms additional shellfish areas are likely to be closed. Decreased coliform counts tend to benefit the socio-economic growth and stability since more clean areas will provide recreation to county residents.

The following recommendations are proposed as an aid to Onslow County planning and public health services:

1) All new dwellings and businesses should be connected to city or county sewage treatment facilities. All existing septic tanks should be monitored periodically to insure conformation to existing regulation; furthermore a thorough analysis of setback distances and related pollution is recommended.

2) A diffuser pipe to carry off storm drainage and excess runoff should be established from Mumford Point running southeast 500-1000 yards into Morgan Bay. This will dilute bacteria carrying waters and will bring bacteria arising from land excess runoff in contact with higher salinity saltwater with antiseptic results.

3) Future landfills should be isolated on soils suitable to bacterial degradation and which will not otherwise

burden the existing levels in the bay. The existing landfill on Northeast creek is minimally adequate but during times of heavy rainfall this creek significantly contributes to bacteria in the estuary.

4) The surrounding watershed, consisting of barren land, should be improved through the planting of suitable ground cover, i.e. grass or trees, in order to increase the holding of water in the soil.

5) Wilson Bay is suspect as a health hazard and should be closed to fishing, swimming and boating pending a thorough sediment study.

6) Evaluation of the capability of all existing sewage disposal and septic systems that handle wastes in the county should be initiated to reflect the needs which are anticipate as the population increases.

7) We urge that tests done on suspected pollution in the estuary use analyses appropriate to distinguish between _E. coli_ and non-human bacteria which give similar results through standard testing such as fecal streptococci and _Pseudomonas aeruginosa_.

INTRODUCTION

The New River Estuary, located in Onslow County, North Carolina, is bordered on the north by Jones County, Duplin County to the west, Carteret County and Onslow Bay on the east and to the south, Pender County. Planners in Onslow County and Jacksonville are presently concerned with the water quality of the New River and its adjacent estuary because of the present and potential use of these waters for boating, swimming, commercial and recreational finfishing and shellfishing. Local sanitary engineers have suggested that the proximity of sewage disposal systems to regional estuaries, the influence of water runoff and the discharges from storm drains and other outflows has added to the bacteriological burden of the bay. Because these waters lie within the urban region dominated by the Camp Lejeune Marine Base, the City of Jacksonville and several other coastal communities, concern for water quality has risen sharply.

Mindful of the potential hazard of coliform bacteria in the estuary, the Onslow County Planning Department has expressed concern about regional water quality. This paper summarizes a 1980-1981 study of water quality of the New River Estuary, Jacksonville, North Carolina. Onslow County's research goals and the goals of this study were 1) to develop a system which would abate the high coliform bacterial levels which presently occur in the river and estuary; 2) to determine specific sources of coliform bacteria; and 3) to assess seasonal changes in the abundance and distribution of coliform bacteria throughout the area. This resultant information will be utilized in decision-making processes affecting recreational and commercial land use.

This study was funded by Onslow County, the City of Jacksonville and North Carolina Department of Natural Resources and Community Development through the Office of Coastal Zone Management (grant number: 2984-80-0043) awarded to the University of North Carolina at Wilmington on November 10, 1980. The principle investigator was Dr. Gilbert W. Bane.

The specific objectives of the funded study are:

1) To assess the coliform distribution in the waters of the New River adjacent to the City of Jacksonville and around the shores of Camp Lejeune Marine Base
2) To define point and non-point sources of pollution in the estuary
3) To demonstrate seasonal and geographic changes in coliform counts in the New River Estuary as an indicator of pollution
4) To present information on the economic consequences of coliform pollution to the residents of Onslow County
5) To evaluate and define appropriate alternatives to the present discharge system.

The research reported in this thesis emphasizes objectives 1,2 and 3. Objectives 4 and 5 were used as supplemental material to show the signifigance of scientific data.

LITERATURE REVIEW

Indicator Organisms

Indicator organisms are associated with the intestinal tract, and their presence in water indicate that the water has received contamination of an intestinal origin. The coliform group of organisms are suitable as indicators because they are common inhabitants of the intestinal tract of humans and other warm-blooded animals and are generally present in the intestinal tract in large numbers. When present in the water environment, the coliform organisms eventually decrease in number (Dawe & Penrose, 1978), but at rates no faster than the pathogenic bacteria, Salmonella and Shigella. Both the coliforms and the pathogens behave similarly during water purification processes (Brock, 1979).

The detection of enteric bacteria, specifically in the Escherichia, Enterobacter, Shigella and Salmonella groups, is not necessarily a statement of safety within the water tested, but serves as a warning signal of potential pathogen presence (Pelczar and Reid, 1972). Thus, coliforms have become the accepted standard for water and shellfish marketability for the U.S. Food and Drug Administration.

Despite significant advancements in the fields of medicine and sanitation, fecal coliform groups continue to create health problems, largely attributable to increased urbanization and the increasing use of broad spectrum antibiotics. Increased population density invariably results in expanded sewage outflow, most commonly in this area into septic tank systems that drain into adjacent lands. The use of antibiotics in relation to the waste disposal problems was addressed by Alexander (1971). He concluded that these antibiotics make possible diseases caused by normally docile strains of Staphlococcus, Proteus and Pseudomonas by eliminating normal bacterial flora.

Wastes from sewage and septic systems, storm drainage and farmland runoff can enter recreational waters. Care must be taken to prevent excessive coliform loads in these waters because they can threaten public health and safety.

Viruses can also be utilized as indicators of fecal pollution since they infect the gastrointestinal tract of man and are excreted with the feces of infected individuals. These viruses are present in domestic sewage which, after various degrees of treatment, enter waterways that serve as a source of water for most large communities. The viruses known to be excreted in relatively large numbers with feces include polioviruses, coxsackieviruses, echoviruses, adenoviruses, reoviruses and the virus of infectious hepatitus (Clark, et. al., 1962 and 1964).

Infections with poliomyelitis virus have been associated with fecally polluted water. Polioviruses are particularily evident during the summer in city sewage. Other viral infections are more frequently associated with the ingestion of polluted water, again particularly in summer. Outbreaks occur repeatedly in individuals using polluted outdoor swimming pools. A common cause of these infections are coxsackie and echoviruses which are regularly found in sewage during the warm season of the year. Certain hepatitis viruses are also associated with polluted water and increases in the colder months (Rheinheimer, 1976).

Sewage treatment, dilution, natural inactivation and water treatment reduce viral numbers from treated waters before that water is supplied for domestic purposes. Large outbreaks of waterborne viral diseases may occur with massive sewage contamination of a water supply. In technologically advanced nations, viral infection and disease are reduced because waste treatment while not completely eliminating pathogenic viruses, decreases their number so that they do not produce infection. (Clarke, et. al., 1962 and 1964.)

Of major importance in the evaluation of water quality is the study of coliform bacteria extant in these waters. As defined by the American Public Health Association (APHA) (1975), the coliform group comprises "bacteria that are aerobic or facultative anaerobic, gram negative, non-spore forming and rod-shaped, that ferment lactose with gas formation within 48 hours at 35° C". Escherichia coli, a common intestinal organism, Klebsiella pneumonia, a less common intestinal organism and Enterobacter aerogenes, an organism not associated with the intestine, currently comprise the coliform group (Brock, 1979). The coliform group can be broken into two components, fecal and nonfecal. Fecal coliform bacteria are found in the fecal matter of all higher animals, including humans and are usually introduced into the water column by septic seepage, sewage outfalls and land runoff. By APHA defination, "fecal coliforms are those that ferment lactose with gas formation in a suitable culture medium in 24 hours at 44.5° C. This differentiation can yield valuable information concerning the possible source of pollution in the water and especially the distance from the source of this pollution. This is possible because the nonfecal members of the coliform group may be expected to survive longer than the fecal members in the unfavorable environment provided by the water (Standard Methods, 1975).

Coliform bacteria can be enumerated using the Multiple-tube Fermentation Technique from Standard Methods for Examination of Water and Wastewater. This technique consists of two parts:

1) The Standard Methods technique for total coliform distribution
   a) Presumptive Test
   b) Confirmed Test
   c) Completed Test
2) The Standard Methods technique for fecal coliform detection
   a) Presumptive Test
   b) Fecal Coliform Test

Each test produces a value, the Most Probable Number (MPN), which is not an actual enumeration of the coliform bacteria, but merely an index of the number of coliform bacteria that, more probably than any other number would give the results shown by the laboratory examination (Standard Methods, 1975). The MPN is a theoretical value determined by statisticians and an example is given in the table in MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT: WATER AND WASTES(1978).

The importance of fecal coliform bacteria in water quality study lies in their usefulness as an indicator organism for many pathogenic microorganisms (Wyss and Eklund, 1971; American Water Works Association and Water Pollution Control Federation, 1971; Wheeler and

Volk, 1964). Table 1 lists pathogenic organisms in the United States for which the coliform bacteria, Escherichia coli is an indicator.

Faust (1976) examined the coliform pollution from land runoff to a stream that entered the Chesapeake Bay. She determined that the fecal coliform discharge rate from this land was seasonal and largely dependent on water flow. The total coliforms were influenced by the same factors. Fecal coliforms persisted in the water; numbers were high in the Rhode River close to discharge points; further away they were diluted out by the river volume. Bacterial persistence at low winter water temperatures in the estuary increases bacterial numbers and apparent pollution levels. This was considered to be the explanation for the high fecal coliform levels in the estuary.

Dilution was observed to be the major influence on fecal coliform counts in the River Lagan Estuary, Northern Ireland, U.K. The fecal coliform counts were found to decrease with increasing river depth (Parker, et.al., 1979).

The presence of coliforms in the water column allows for the development of modeling systems. Kelch and Lee (1978) developed a computer-assisted, multiple linear regression analysis program to predict the fecal coliform levels in the estuarine environment. They used data collected by isolating fecal coliforms on Millepore HAWG membranes and examining their resistance to 12 antibiotics. A total of 135 independent variables were analyzed to determine their correlations with two dependent variables - bay fecal coliform count and log bay fecal coliform count. Relationships were noted between these dependent variables and ambient temperature, precipitation, recreational use of the tributaries, antibiotic resistance levels and

TABLE 1

Pathogenic Organisms for which *Escherichia coli* is an indicator.

	ORGANISM*	DISEASE
Bacteria		
	Salmonella typhi	Typhoid Fever
	Vibrio cholerae	Cholera
	Shigella sp.	Shigellosis
	Salmonella paratyphi	Salmonellosis
	Escherichia coli (pathogenic strains)	Gastroenteritis
	Leptospira sp.	Leptospirosis
	Francescilla tularensis	Tularemia
Viral	Hepatitis A Virus	Infectious hepatitis
	Polio Virus	Polimyelitis

*These organisms have been in epidemic proportion in the U.S. (1946-1975) (Brock, 1979).

fecal counts in the tributaries.

Fecal Streptococci

The normal habitat of fecal streptococci is the intestine of man and animals; thus, these organisms are additional indicators of fecal pollution. Counts of fecal streptococci provide valuable supplementary data on the bacteriological quality of lakes, streams and estuaries, because streptococci persists longer and are better indicators than coliforms for past pollution. However, most valuable application of the fecal streptococci test is the determination of ratios of fecal coliform to fecal streptococci. Because coliform predominates over streptococci in human feces, ratios of 4.0 or higher typically indicate domestic waste while ratios of 0.6 or lower indicate discharge from farm animals or storm water runoff. (Standard Methods, 1975). Gore and co-workers (1979) examined fecal coliform: fecal streptococci ratios in the Cochin (India) backwaters. The ratio indicated that the principle source of fecal pollution is nonhuman type originating from land drainage, discharge of organic waste and sewage discharge.

Pseudomonas aeruginosa

According to Standard Methods (1975), Pseudomonas aeruginosa is important in recreational waters because it is an "opportunistic" human pathogen which may multiply in recreational waters in the presence of sufficient nutrients. Its enumeration is valuable because it may indicate the discharge of nutritive wastes into receiving waters. Cabelli and co-workers (1976) examined the relationship of P.

aeruginosa levels to fecal coliform densities in estuarine and fresh recreational waters at varying distances from known pollution sources in Lake Michigan. They showed that P. aeruginosa may indicate pollution of recreational waters by human wastes, especially where the probability of bacterial multiplication is minimal. High fecal coliform densities coincident with low P. aeruginosa levels suggest that the source of fecal pollution is animal rather than human.

The last indicator organism to be discussed is yeast. Hagler and Mendonca-Hagler (1981) found that total yeast counts above 100 CFU/100 ml were typical of heavily and moderately polluted waters but atypical of lightly polluted and unpolluted areas. Total yeast counts were proportional to pollution levels. They found Candida krusei and phenotypically similar yeasts were prevalent in polluted estuarine water but rare in unpolluted seawater.

Environmental Variables

Heterotrophic bacteria numbers have been estimated in estuaries by Wood (1953,1959, 1965), Velankar (1955) and Oppenheimer (1960). Velankar, working in the Gulf of Manaar, India, recorded bacterial populations levels at the surface of the water and close to the bottom. He found that the viable count range from less than 100 to 850 colony forming units (CFU)/ml at the water surface, but was usually on the order of 200 to 300 CFU/ml. He also demonstrated that bacterial counts varied with the number of barnacles and other larvae on test panels in Sydney Harbour (Dew and Wood, 1955). In the water of Lake Macquarie, an irregular seasonal distribution of bacteria was found with a maximum viable count in June-July (Australian winter).

The surface counts were also slightly higher on the average than those from close to the bottom, but the numbers were of the same order as those reported by Velanker (1955). The range of counts (5 to 13,000/ml) was much greater than that found by Velankar, due no doubt to the nutrients washed into the lake by flash floods. Microbial populations of estuarine sediments have also been studied. Oppenheimer found that aerobic bacteria from the sediment surface in Texas Bay ranged from 5×10^{5} to 5×10^{6} and Wood recorded bacterial counts from 3×10^{5} to 6.5×10^{5} in Lake Macquarie.

The sediments of an estuary can serve as a reservoir for indicator bacteria. In the sediments of Lynnhaven Estuary, Virginia, the concentration of indicator bacteria was extremely high and even the indicator organisms may pose a potential health hazard. Disturbance of the uppermost sediment layer by commercial, natural and recreational activities, such as dredging, boating, tides or storms would resuspend the existing fecal organisms (Erkenbrecher, 1980). Goyal and co-workers (1977) found a similar situation in Texas. He found total coliforms, fecal coliforms and Salmonella in greater number in sediments than in overlying water. Heavy rainfall resulted in large increases in the number of organisms in both water and sediment samples. The bottom sediment in the shallow canal systems can act as reservoirs of enteric bacteria, which may be resuspended in response to various environmental factors and recreational activities. The problem of resuspension of sediment-bound fecal coliforms was also examined in the Mississippi River (Grimes, 1975). Fecal coliform concentrations increased significantly in the immediate vicinity of a dredging operation. Increased counts were attributed to the distribution and relocation of bottom sediments by dredging and a concomitant release of sediment-bound fecal coliform.

Saylor and co-workers (1975) enumerated total viable, heterotrophic bacteria, total coliform, fecal coliform and fecal streptococci in the Chesepeake Bay and found significant levels of pollution indicator organisms in all samples. The indicator organisms distribution was independent of temperature, salinity and the concentration of suspended sediments. Most total viable bacteria counts (53%) and fecal indicator counts (80%) were directly correlated with suspended sediments concentrations. Correlation coefficient (r) for the indicator organisms examined in this study were r= 0.80 for bottom water and r= 0.99 for suspended sediments. Prolonged survival of fecal streptococci in most sediment samples was observed. This is probably due to bottom sediments having a high absorptive capacity and the ability to regulate basic nutrient concentration and eutrophication in situ (Hendricks, 1971).

Runoff affects coliform counts in the estuary. Faust (1976) determined the rural watershed contributed to the fecal coliform pollution of the Rhode River and calculated that on the average 1% of fecal coliform produced by the animals was washed into the estuaries by land runoff. These results agree with those of Doran and Linn (1979) who compared grazed and ungrazed pastureland in eastern Nebraska. Total coliform, fecal coliform, fecal streptococci were monitored. Bacteriological counts in runoff from grazed areas contained five to ten times more fecal coliform than runoff from fenced, ungrazed areas. Total coliform levels were the same at the two sites, but fecal streptococci counts were higher in runoff from ungrazed areas and reflected the contribution from wildlife. The fecal coliform / fecal streptococci ratio in pasture runoff was used in in this study to identify the relative contribution of cattle and wildlife. Ratios below 0.06 were indicative of wildlife sources and ratios above 0.1 were characteristic of grazing cattle.

Karthegisan and Thomas (1976) found the number of fecal coliform, total coliform and E. coli type 1 to be related to the salinity conditions of the tidal water covering the sites. These results are similar to those of the Lynnhaven Estuary, Virginia where indicator bacteria varied substantially throughout the estuary, but the higher salinity water and coarser sediments of the inlet showed lower overall bacterial counts than the headwater sites where freshwater runoff decreased tidal effect (Erkenbrecher, 1980). This reduction in bacterial count could be due to debilitation and dilution (Dawe and Penrose, 1978). When the bacteria enter salt water, they become stressed, will not grow on selective media, and were not competitive with other bacteria.

Sewage treatment plants, septic systems and boating activity influences the number of bacteria in the estuary. Sewage disposal and septic tank seepage in estuarine systems provided a major method of pathogenic introduction to estuarine ecosystems. Infectious viruses were especially hazardous because they can be recovered in estuarine waters 46 weeks after dumping. Increasing frequency of antibiotic resistant bacteria, found in the Chesapeake Bay and New York Bight, is also cause for alarm (Colwell and Kaper, 1977). Septic system failures were also found to pose a serious health hazard in the Lynnhaven Estuary, Virginia (Erkenbracher, 1980).

To estimate the potential hazards of sewage disposal, modeling experiments have been performed (Kuo and Jacobson, 1976). They predicted the distribution of sewage constituents that would result from a proposed sewage outfall in estuaries or coastal seas. Application of the technique required dye dispersion experiments and a numerical model employing the results of the experiments. The method was used to assess the environmental impact of a proposed sewage outfall in Hampton Roads, Virginia. Data from dispersion experiments were used to predict the concentration patterns of total nitrogen, total phosphorus, coliform bacteria, BOD, dissolved oxygen deficit and chlorine residuals that would result from the proposed sewage outfall.

Bane and Walker (1980) conducted a study of coliform related marine pollution in Brunswick County, North Carolina, where it was discovered that the total and fecal coliform populations vary at a rate directly proportional to the change in boating activity. The only measured environmental stimulus that affected the total and fecal coliform count was rainfall.

Coliphages are indicators of enteric viruses in shellfish and estuarine waters containing shellfish (Vaughn and Metcalf, 1975). Synoptic examinations of sewage effluents, shellfish and shellfish growing waters for coliphage and enteric viruses indicate a wide dissemination of coliphage throughout Great Bay Estuary, NH, but no resulting public health problem occured. The serious shortcomings of the coliphage indicator system for enteric virus detection are the potential for the presence of more than one dominant coliphage type and the inability to relate coliphage and pathogenic enteric virus occurrence in field samples.

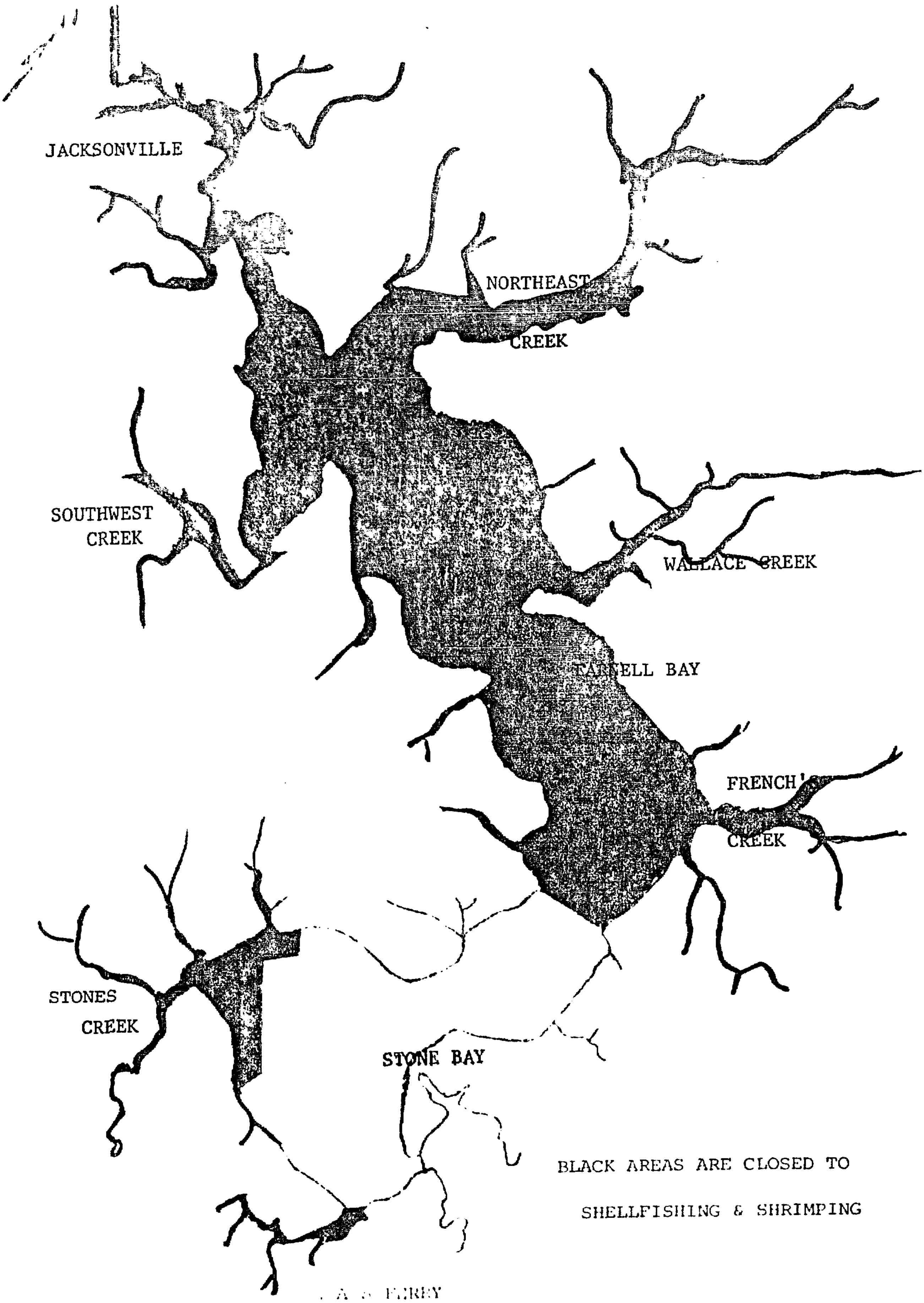
The pollution of oysters was examined in Hong Kong (Morton, 1975) where oysters are cultured by the primitive method of bottom-laying in polluted water. the oysters are fecally contaminated, particularly in the summer when monsoons flush out contaminants from rivers and streams into oyster producing areas. The contamination level is high and comprises effluents derived largely from the neighboring agricultural areas of Hong Kong and southern China.

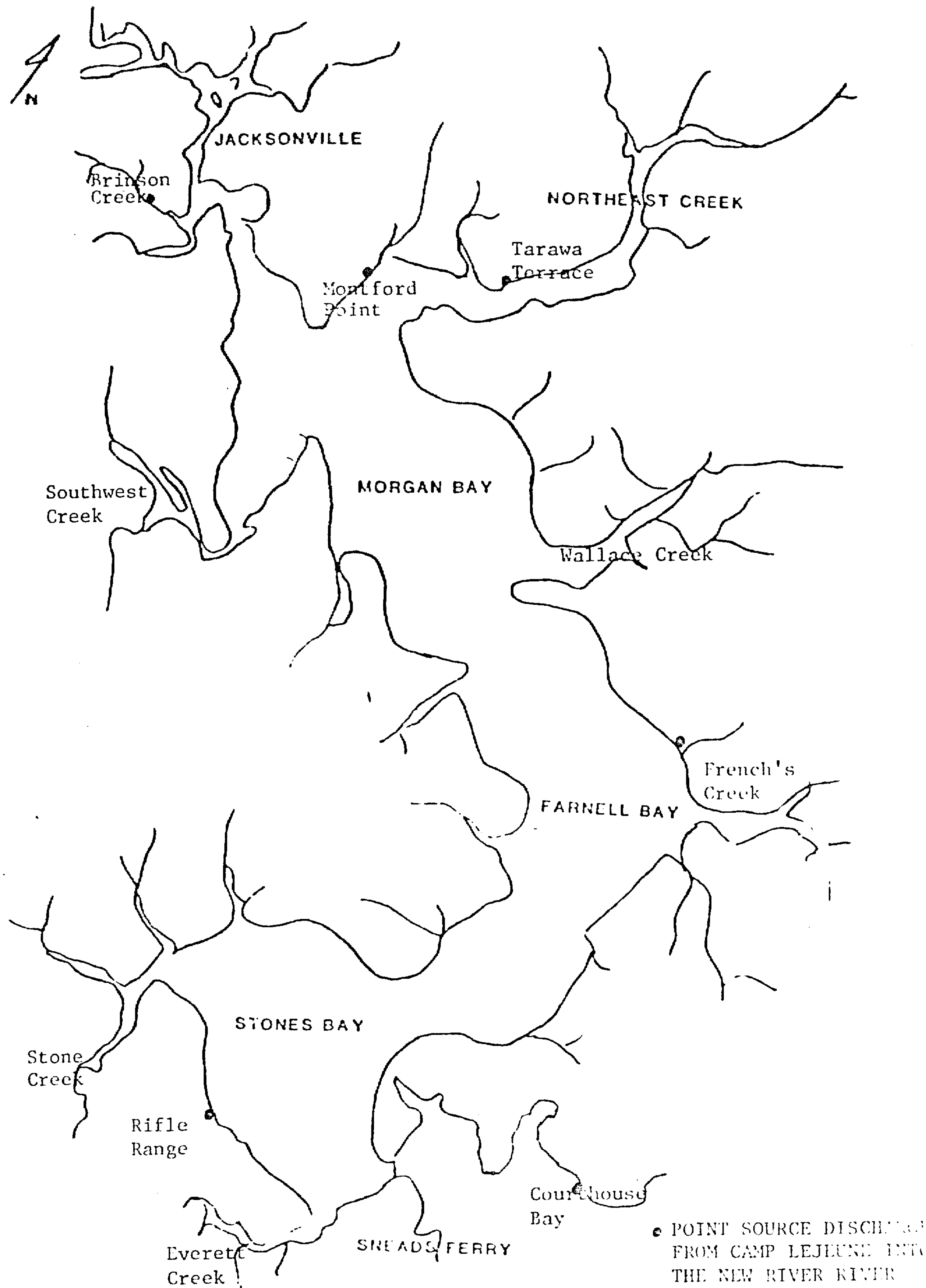
The North Carolina Shellfish Sanitation Program, Division of Health Services, runs surveys every other year of the oyster beds and waters of Stones Bay (New River Estuary, Jacksonville, N. C.) to monitor the coliform levels in the oysters. The only area in the upper New River estuary closed to shellfishing is Everett Creek. (See p.15-a)

Economic Significance

A final important consideration of estuarine pollution is the economic loss of our estuarine resources. One major drawback is attempting to put a dollar value to the damage observed. The economic losses can range from a few thousand dollars to several million dollars per incident of estuarine damage, i.e., shellfish restrictions, duck death due to oil spills, shoaling of a major harbor due to improper hydraulic modification, loss of coastal marsh, loss of swimming recreation due to high coliform counts and lack of potable water (Wasserman, 1970).

The National Science Foundation-funded SOS project at UNC-Wilmington (Bane, Manuscript) evaluated the socio-economic loss by bacterial pollution to fishermen in Brunswick County. The loss was determined to be $421,117.00, affecting 40 full-time jobs per year; this represents a negligible loss when compared to total Brunswick County seafood resources, but a large loss to the individual fisherman.


JACKSONVILLE
NORTHEAST
CREEK
SOUTHWEST
CREEK
WALLACE CREEK
STONES
CREEK
STONE BAY
BLACK AREAS ARE CLOSED TO
SHELLFISHING & SHRIMPING


N
JACKSONVILLE
Brinson Creek
NORTHEAST CREEK
Tarawa Terrace
Montford Point
MORGAN BAY
Southwest Creek
Wallace Creek
French's Creek
FARNELL BAY
STONES BAY
Stone Creek
Rifle Range
Courthouse Bay
Everett Creek
SNEADS FERRY
POINT SOURCE DISCHARGE FROM CAMP LEJEUNE INTO THE NEW RIVER RIVER

METHODS AND MATERIALS

A total of 366 bacteriological samples from 65 sampling sites was collected between November 30, 1980 and December 7, 1981. The sampling dates are listed on Table 2. The sampling area was the region of the New River Estuary between Stones Bay and the river north of Jacksonville (Figure 1). Sample sites, indicated on the map in Appendix I, were selected for their proximity to either permanent channel markers or automobile bridges. Seven sites designated major stations (Figure 2) were sampled at least once per month and the remaining 58 stations were sampled at least three times and are designated by station number identifier codes. The location of these stations are given in Appendix I. Samples at major stations also had identified codes (see Figure 2 for explanation).

FIELD COLLECTION

Thirteen student workers assisted in field and laboratory analysis of which eight were funded and five received credit in Seminar in Environmental Studies, EVS 495. The students worked under the direct supervision of the Project Director and performed routine tasks in order to allow for increased numbers of samples to be analyzed.

Water for analysis was collected in presterilized 200 ml glass bottles. The bottles were submerged a few inches below the water surface by a gloved hand with the bottle mouth facing upstream. The bottles were filled with 25 mls of air left in the top. The samples

FIGURE 1 - NEW RIVER ESTUARY SAMPLE AREA AND RAIN GAUGE LOCATIONS

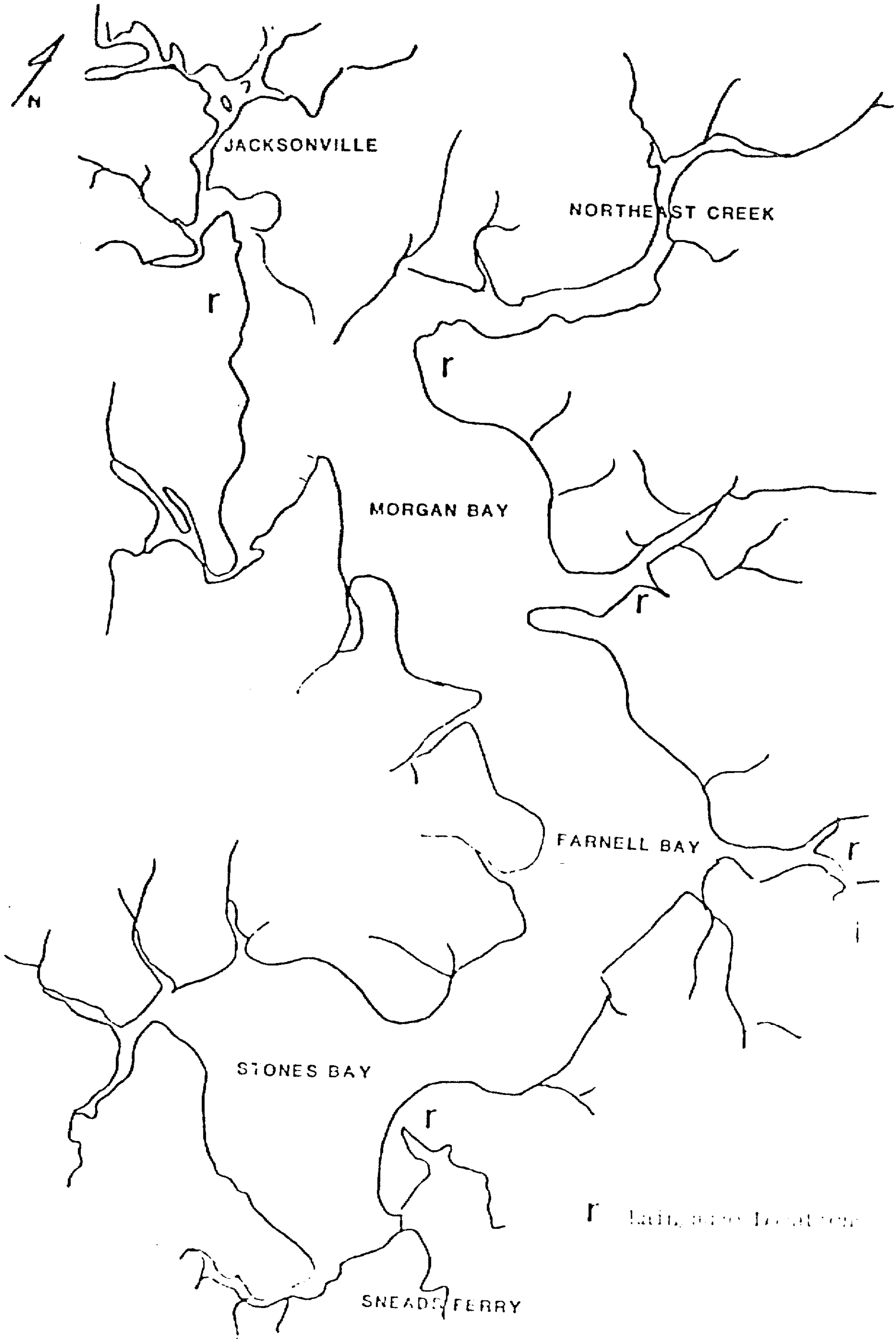

N
JACKSONVILLE
NORTHEAST CREEK
MORGAN BAY
FARNELL BAY
STONES BAY
SNEADS FERRY
r
r
r
r
r
r

FIGURE 2 - SEVEN MAJOR SAMPLING STATIONS IN THE NEW RIVER ESTUARY

STATION 1 IS STATION NUMBER IDENTIFER CODES 22 - 37

STATION 2 IS STATION NUMBER IDENTIFER CODES 81 - 95

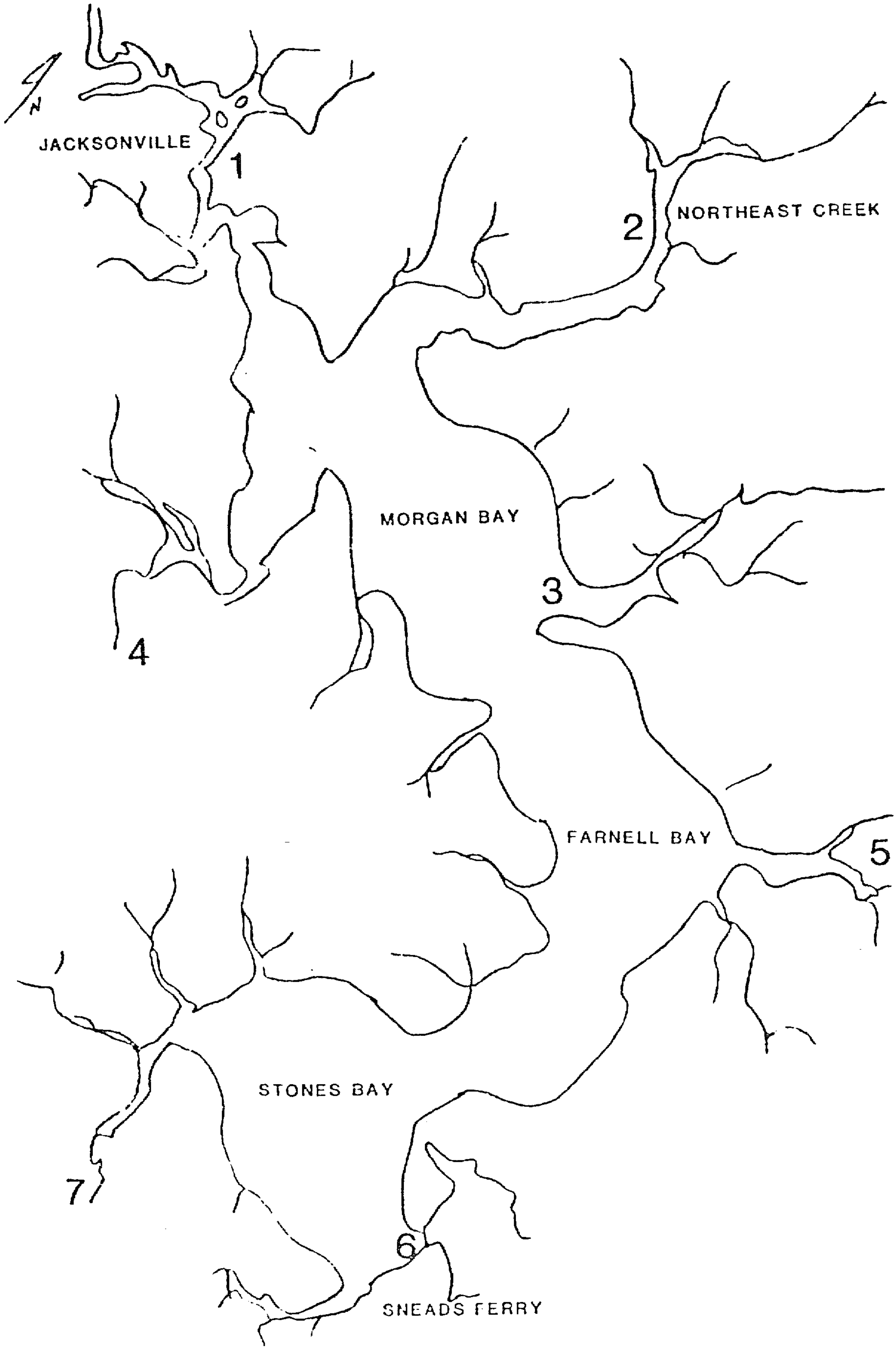
STATION 3 IS STATION NUMBER IDENTIFER CODES 160 - 177

STATION 4 IS STATION NUMBER IDENTIFER CODES 133 - 142

STATION 5 IS STATION NUMBER IDENTIFER CODES 254 - 264

STATION 6 IS STATION NUMBER IDENTIFER CODES 356 - 366

STATION 7 IS STATION NUMBER IDENTIFER CODES 347 - 355


N
JACKSONVILLE
1
2
NORTHEAST CREEK
MORGAN BAY
3
4
FARNELL BAY
5
STONES BAY
7
6
SNEADS FERRY

were stored on ice during transit to the laboratory. No more than six hours elapsed from collection time to laboratory processing. In the field, salinity was determined with a hand-held refractometer (All commercial suppliers are listed in Appendix II); water and air temperatures were recorded with a mercury thermometer. Phosphate, nitrate, dissolved oxygen and turbidity tests were determined using the Hach DR-EL/4 according to the manufacturers specifications. Dissolved oxygen was also determined with a portable field oxygen meter. Rainfall measurements were obtained from Tru-check rainfall gauges (locations on Figure 1); and additional information was obtained from the Environmental Center at Camp Lejeune Marine Base and the Camp Lejeune Air Station.

LABORATORY ANALYSIS

To avoid ion contamination, water was distilled using a Corning Mega-pure still.

The coliform counts, fecal streptococci counts and Pseudomonas aeruginosa counts were determined following the protocol in Standard Methods. The only change was the MPN table from MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT: WATER AND WASTES (1978) was used because it is more complete than Standard Methods.

Presumptive Test

Upon returning to the laboratory, 1 ml from each sample was placed into each of 5 test tubes containing single-strength lauryl tryptose. Another 1 ml of sample was placed in 9 mls of phosphate buffer, to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes containing single-strength lauryl tryptose. One ml of the 0.1 dilution was placed in another 9 mls of phosphate buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of single-strength lauryl tryptose.

An inverted Durham tube was placed in each test tube to concentrate gases and to indicate positive or negative results. A positive presumptive test shows gas formation after incubation of 24 hours or 48 hours at 35° C.

Confirmed and Fecal Coliform Tests

Each positive presumptive test was used to inoculate an EC Medium and a 2% Brilliant Green Bile Broth (BGB), performed with a sterile wooden swab submerged once around the lauryl tryptose tube, once around the EC tube and finally once around the BGB. The EC Medium was incubated in a water bath at 44.5°C for 24 hours. A positive reaction for fecal coliform is indicated by gas formation in the inverted Durham tube after incubation.

The BGB tubes are incubated at 35° C for 24 hours or 48 hours. The formation of gas in an inverted Durham tube indicates a positive test for coliform bacteria.

Completed Test

The positive confirmed tubes are inoculated onto Eosin Methylene Blue (EMB) agar plates; EMb is a medium that cultures only gram negative rods. The plates are incubated at 35° C for 24 hours and were used to tentively identify specific organisms: Escherichia coli has a dark metallic green sheen; Enterobacter aerogens produces a colony with a dark nucleus but no metallic green sheen; Klebsiella sp., large pink mucoid colony; and Proteus sp., spreading pink colony with a foul odor. A positive EMB test indicates *E. coli*.

FECAL STREPTOCOCCI

Presumptive Test

One ml of sample was placed into each of 5 test tubes containing 10 mls of single-strength azide dextrose broth. Another 1 ml of sample was placed in 9 ml of phosphate buffer to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes. One ml of the 0.1 dilution was placed in another 9 ml of buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of azide dextrose broth.

The inoculated test tubes are incubated at 35° C for 24 hours or 48 hours. A positive presumptive test shows turbidity after incubation.

Confirmed Test

Each positive azide dextrose broth was transfered to a tube of ethyl violet azide broth. The transfer was performed with a sterile wooden swab from the azide dextrose to the ethyl violet azide broth.

The inoculated tubes are incubated for 48 hours at 35° C. A positive confirmed test was indicated by the formation of a purple button at the bottom of the tube or occasionally by a dense turbidity.

PSEUDOMONAS AERUGINOSA

Presumptive Test

One ml of sample was placed in each of 5 test tubes containing 10 mls of asparagine broth. Another 1 ml of sample was placed in 9 ml of phosphate buffer, to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes of asparagine broth. One ml of the 0.1 dilution was placed in another 9 mls of buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of asparagine broth.

The inoculated test tubes were incubated at 35 °C for 24 hours or 48 hours. The medium in a positive presumptive test tube will fluoresce when exposed to long wave ultra-violet light.

Confirmed Test

One drop of asparagine broth was removed from a positive presumptive tube and placed on an acetamide agar slant. The tubes were incubated at 35 to 37 °C for 24 to 36 hours. A positive confirmed test was indicated by the development of an alkaline pH in the medium as indicated by a purple color.

SURVEY

A survey was taken to determine the use of the New River by boaters and fishermen, both commercial and recreational. A list of the addresses of owners with boat permits was obtained from North Carolina Division of Marine Fisheries. A random selection of 200 owners were sent questionnaires (Appendix III) and another 62 questionnaires were sent to local fishing clubs.

RESULTS

The MPN's of each of the seven major stations that were sampled from November 1980 to December 1981 are shown individually in Figures 2-9. The data from the remaining 58 minor stations are shown in Appendix I. The fecal coliform counts (EC counts) ranged from 0 (Figures 3,4,5,7,8) to 16000 (Figure 4) (mean = 1200). The total coliform counts (EMB counts) range from 0 (Figures 3,4,5,7,8,9) in the winter to 24000 (Figure 3) in the spring (mean = 400). Both EC and EMB counts are high in the streams and decrease in the bay.

The range, mean, standard deviation and standard error for each station are shown in Figure 10 (EC counts) and Figure 11 (EMB counts). The EC counts are highest in the northeast quadrant of the New River Estuary, especially in the river at Jacksonville (mean = 1300) and in Northeast Creek (mean = 949). The lowest values occur in Stones and Farnell Bays which had high tidal fluctuation, deep water and lower human population on adjoining land areas. The lowest EMB counts occur in the middle water of the estuary (range 21 to 231). Highest EMB counts were along the northeast shore, especially at Wallace Creek (mean = 1760). Other high counts occur in Frenchs and Northeast Creeks. EMB counts on the western shore ranged from 0 to 24000 (mean =1200). South and western shores had moderate counts (mean = 550).

Most of the study area was rural and unpopulated. The exceptions were Jacksonville (Station 1), Northeast Creek (Station 2), Camp Lejeune Marine Base (eastern shore) and Dixon (Station 7). These areas were thought to contribute to the bacterial concentration in the New River area.

University of North Carolina
at Wilmington
28406

DEPARTMENT OF BIOLOGY
MARINE SCIENCE BUILDING 141
POST OFFICE BOX 3725

March 21, 1983

Mr. F. Winley
Onslow County Planning Dept.
39 Tallman Street
Jacksonville, NC 28540

Dear Mr. Winley:

I will attempt to answer the questions you posed concerning the work Dr. Bane did for you while he was here. I was not involved with Dr. Bane's contract but I am familiar with the work done by Cathy Rozowski, Dr. Bane's graduate student. Ms. Rozowski was the primary data collector on the contract and the report presented to you represents part of her master thesis work. I am a microbiologist and was also part of the committee which reviewed her thesis.

You seemed most concerned with the data in the report which demonstrated higher numbers of fecal coliforms than total coliforms at some sampling sites. I can understand your concern. Fecal coliforms are a subset of the coliform group and, in theory, fecal coliform numbers can equal, but never exceed, the number of total coliforms. The apparent reason that fecal coliforms surpass coliforms is that two different enumeration techniques were used to collect the two sets of data. Both enumeration methods are correct, acceptable and recommended by Standard Methods for the Examination of Water and Waste Water (14th edition). Both techniques enumerate in terms of MPN (most probable number) values which are merely statistical estimates of actual numbers present and variation in values can be expected. Both techniques are more precise (repeatable) than accurate. The data generated by either technique is best interpreted only by comparing values between stations analyzed by the same techniques. Graphing both sets of data on the same figure is probably misleading.

Standard Methods recommends both procedures for monitoring fecal pollution of water. The total coliform technique is the older, more established procedure, used extensively for evaluating the quality of drinking water. The fecal coliform test is used to differentiate fecal from nonfecal coliforms. It is not recommended for examination of water potability but is recommended and used extensively for monitoring stream and seawater pollution (Standard Methods pg. 876 & 922). In my opinion, the fecal coliforms count is the better technique for estimating the extent of intestinal coliform pollution and may be the number which you wish to use.

If you have any additional questions which I might help you with, please feel free to call me at 791-4330, extension 2478.

Sincerely,

Ronald K. Sizemore
Assistant Professor

RKS:lrr

cc: Dr. James F. Merritt
Ms. Lynne Crater

FIGURE 3 - BACTERIOLOGICAL ANALYSIS OF STATION 1 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

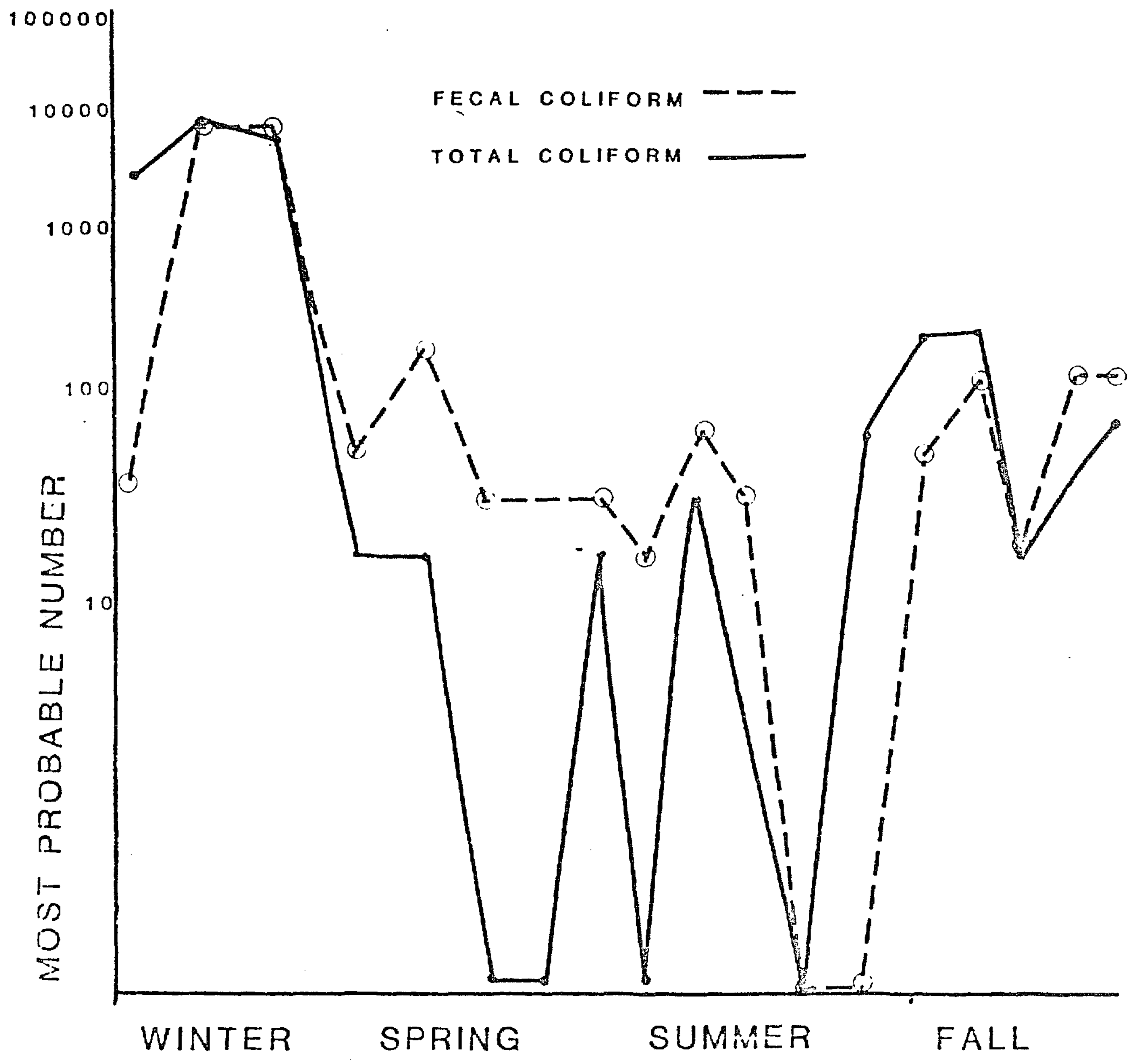

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 4 - BACTERIOLOGICAL ANALYSIS OF STATION 2 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

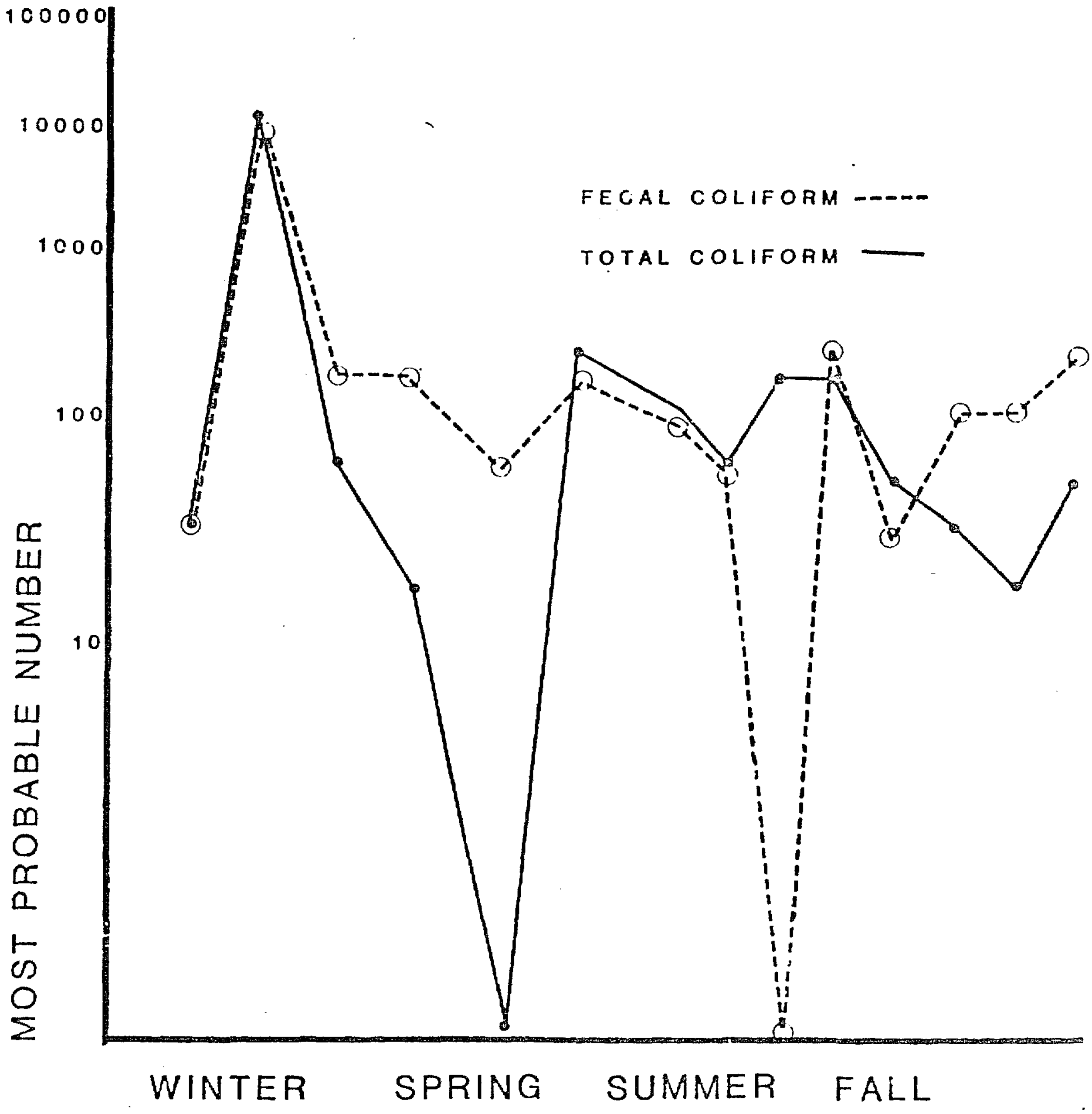

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 5 - BACTERIOLOGICAL ANALYSIS OF STATION 3 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

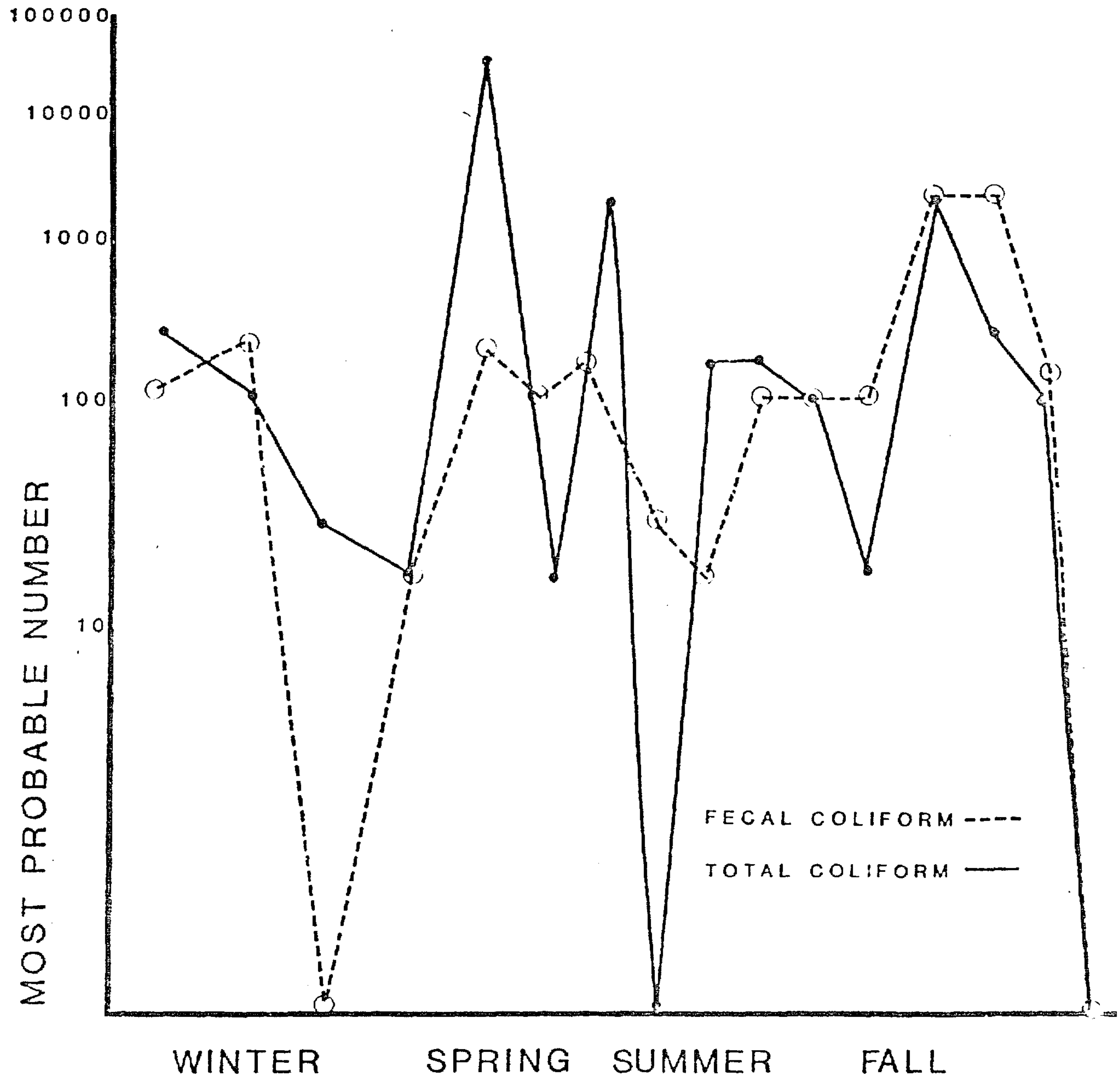

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM ----
TOTAL COLIFORM ——
WINTER
SPRING
SUMMER
FALL

FIGURE 6 - BACTERIOLOGICAL ANALYSIS OF STATION 4 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

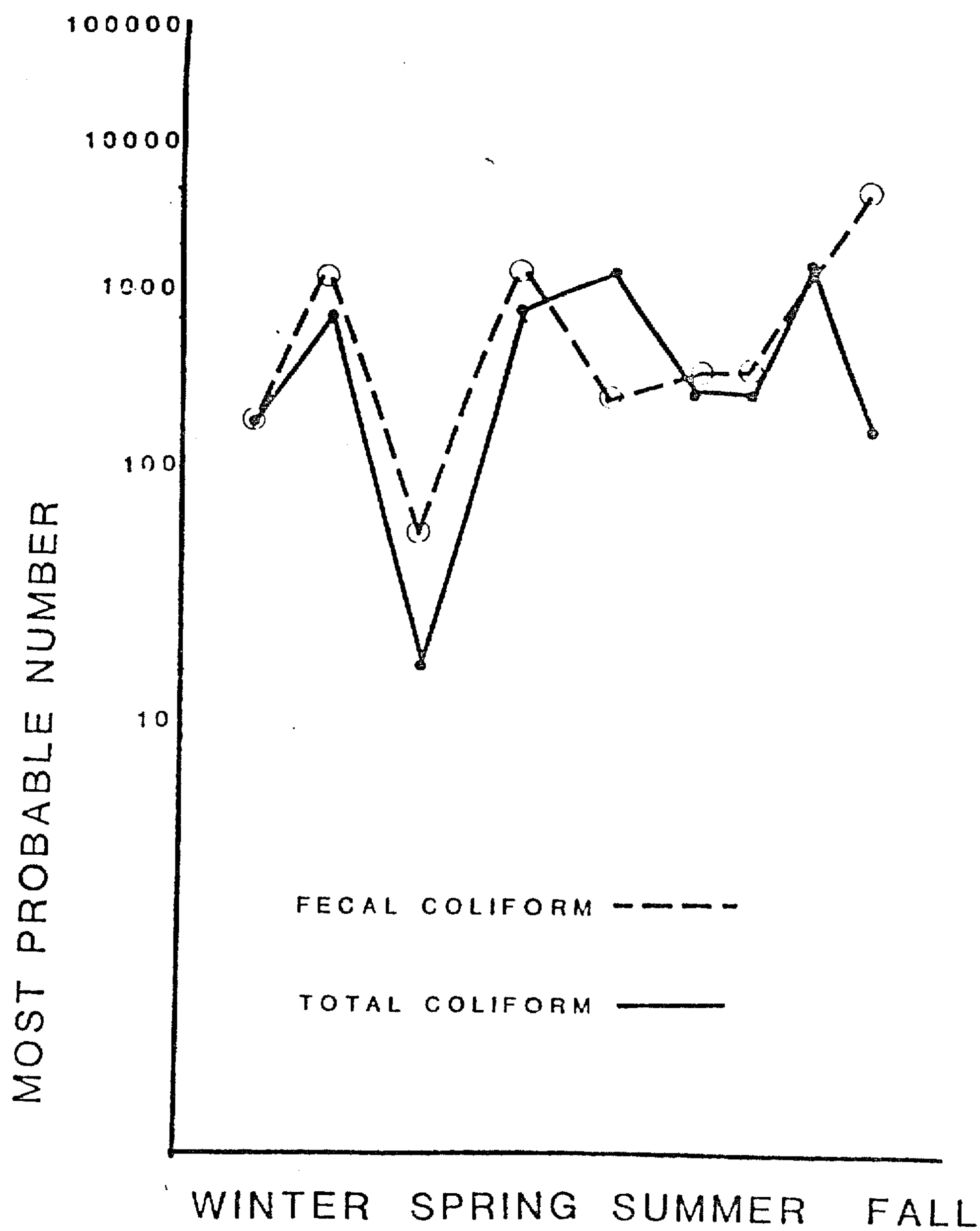
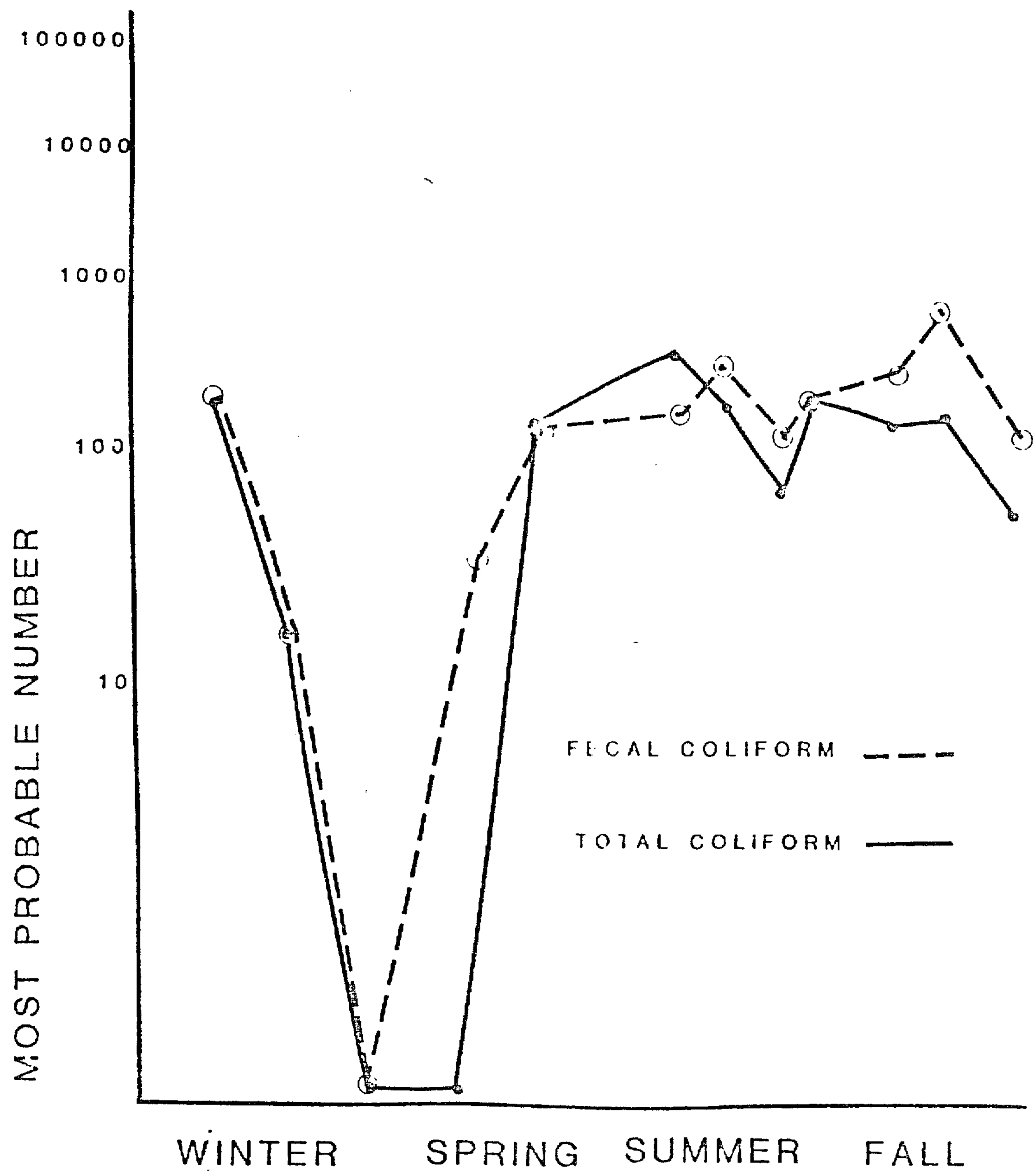
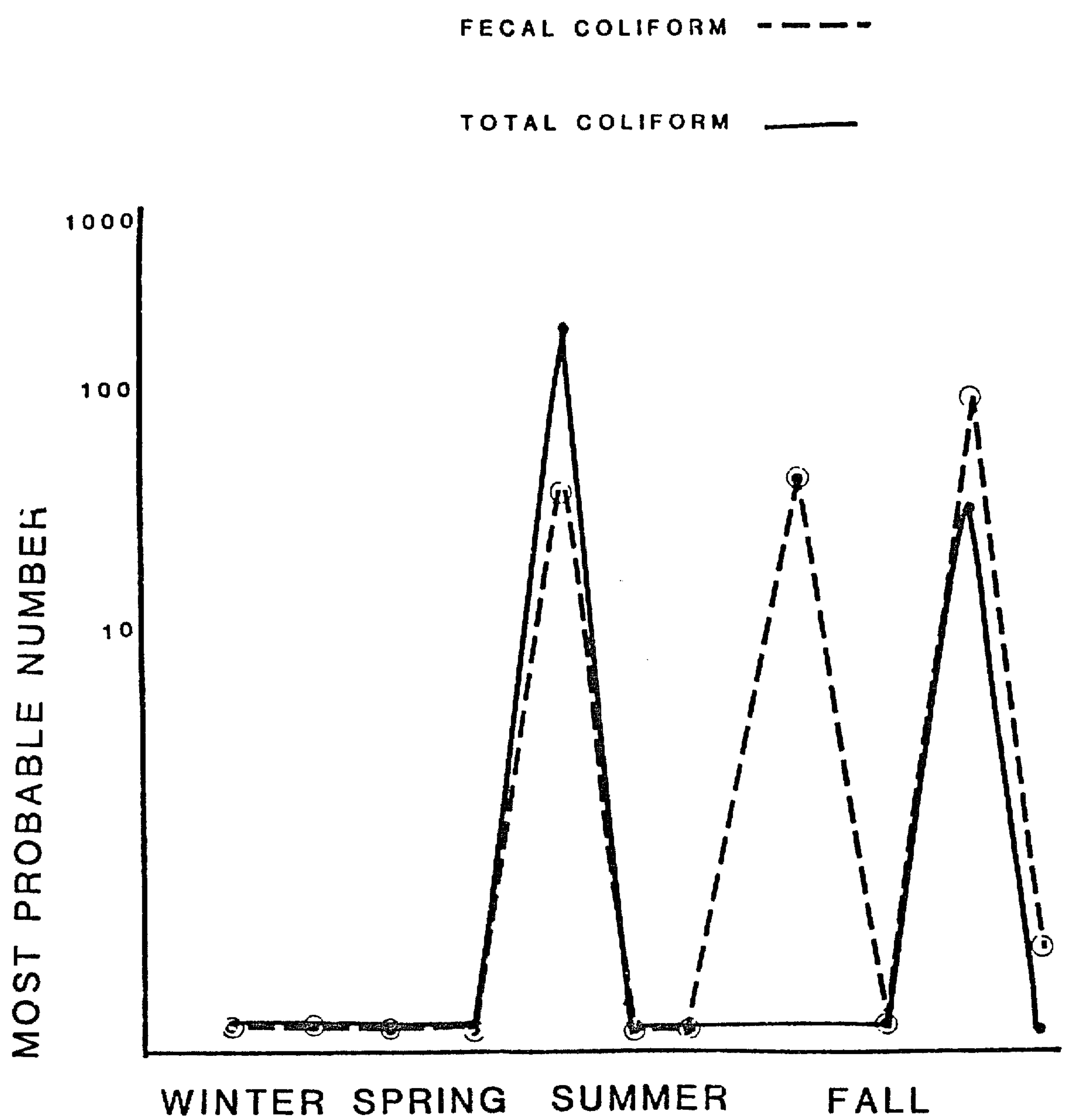

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 7 - BACTERIOLOGICAL ANALYSIS OF STATION 5 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY



100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 8 - BACTERIOLOGICAL ANALYSIS OF STATION 6 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY



FECAL COLIFORM
TOTAL COLIFORM
1000
100
10
MOST PROBABLE NUMBER
WINTER
SPRING
SUMMER
FALL

FIGURE 9 - BACTERIOLOGICAL ANALYSIS OF STATION 7 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

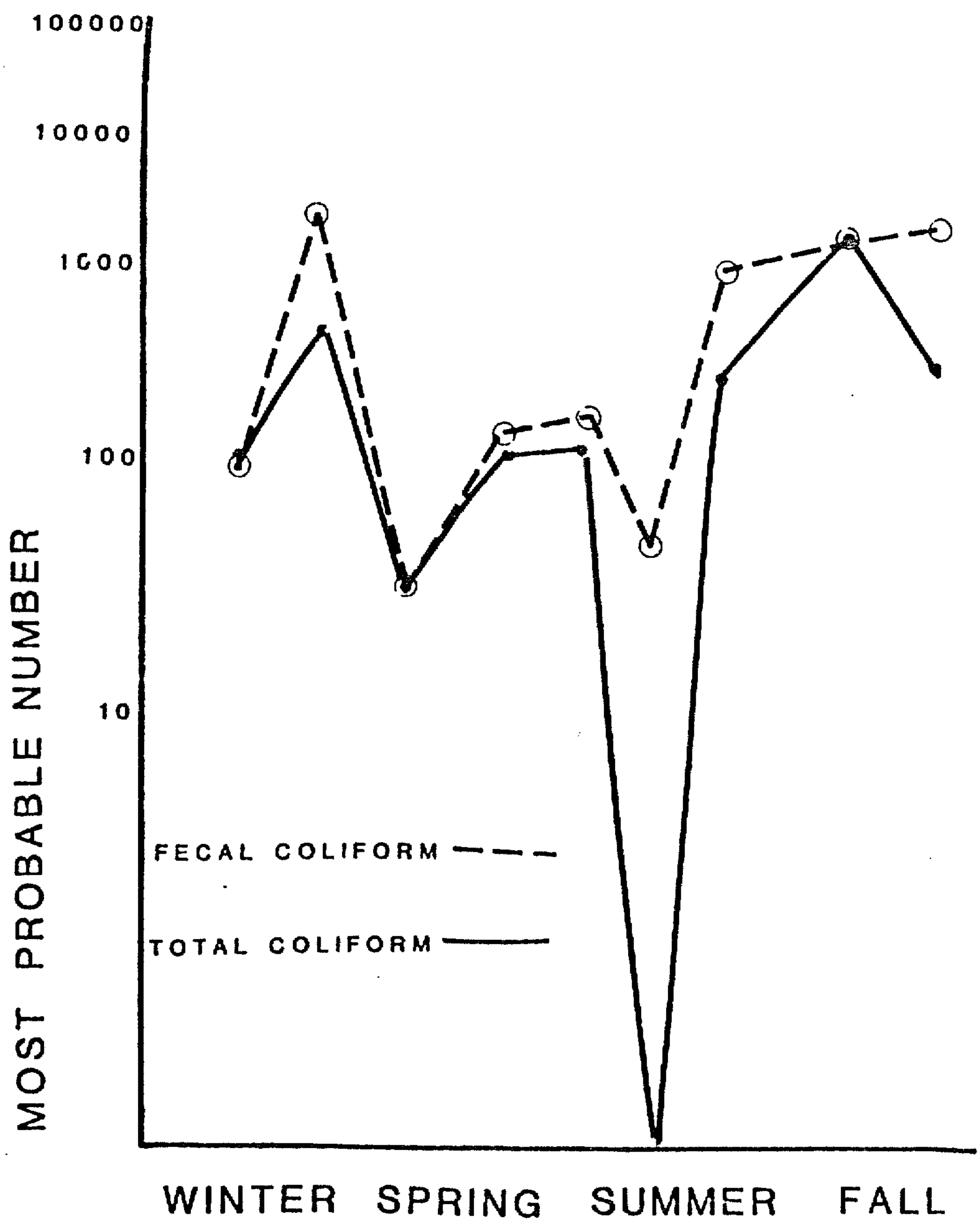
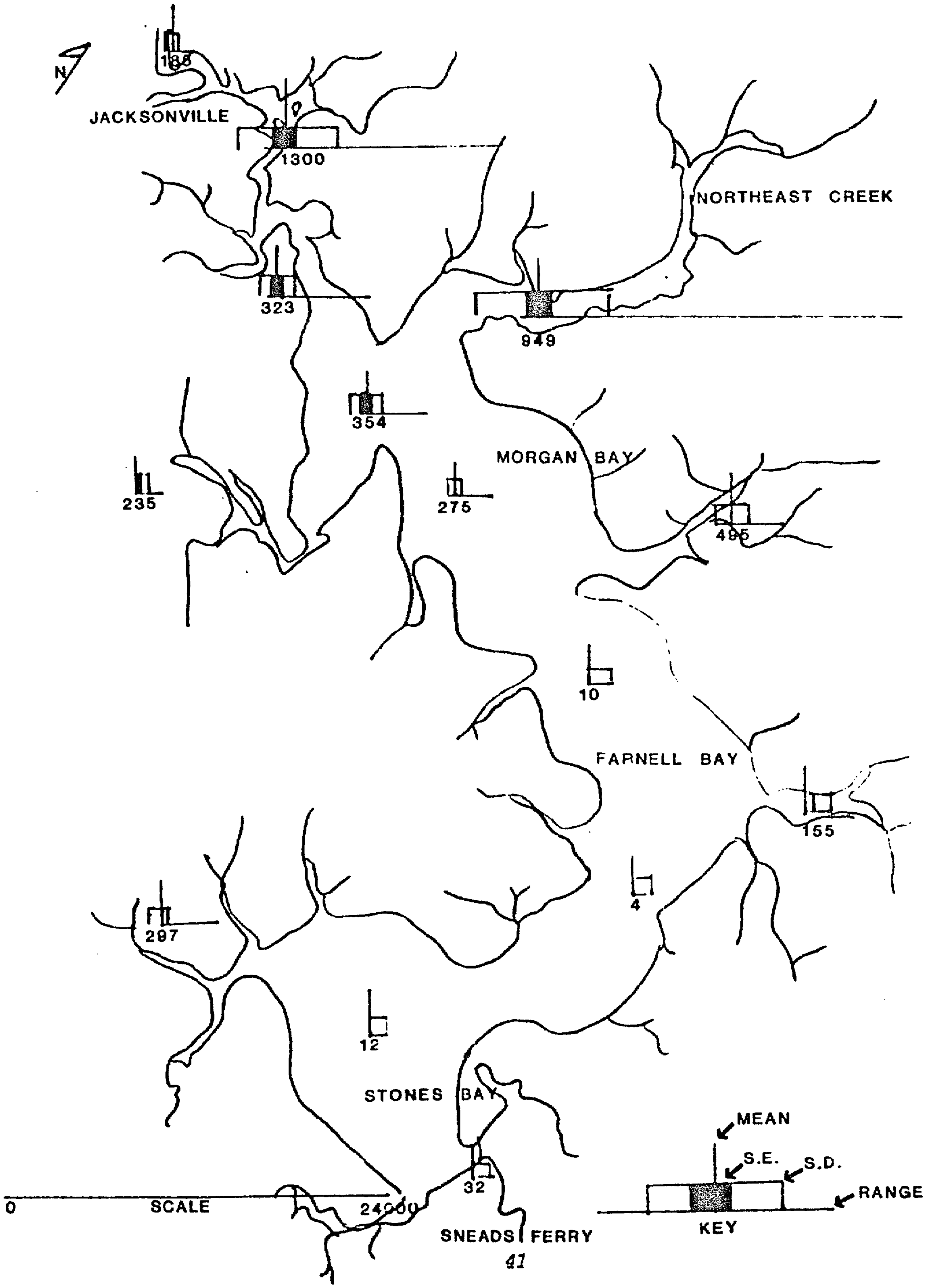
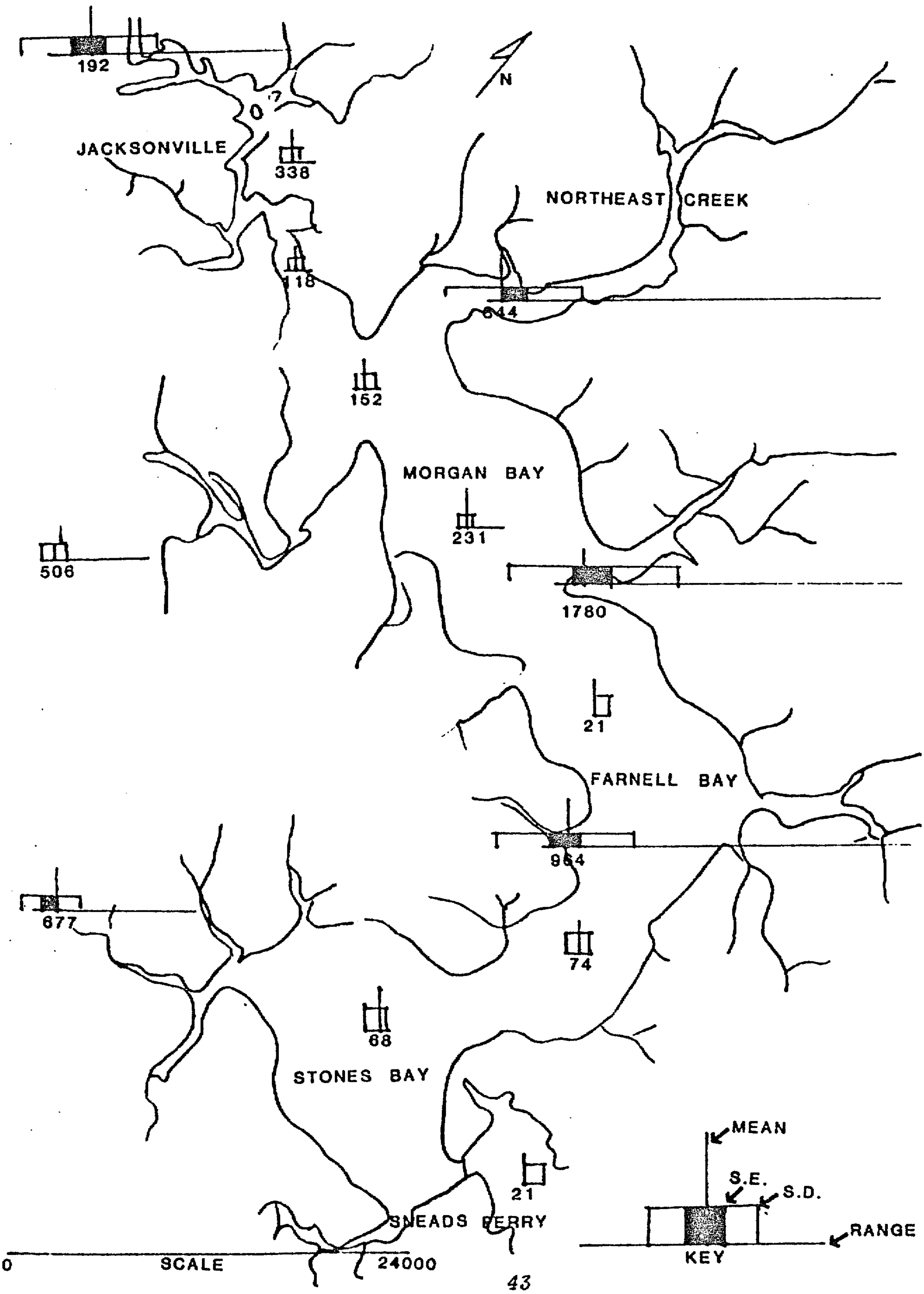

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 10 HUBBS-HUBBS DIAGRAMS OF FECAL COLIFORM (EC) COUNTS IN NEW RIVER ESTUARY FROM NOVEMBER 1980 - DECEMBER 1981



N
JACKSONVILLE
188
1300
NORTHEAST CREEK
323
949
354
MORGAN BAY
235
275
495
10
FARNELL BAY
155
4
297
12
STONES BAY
32
0
SCALE
24000
SNEADS FERRY
MEAN
S.E.
S.D.
RANGE
KEY

FIGURE 11 - HUBBS-HUBBS DIAGRAMS OF TOTAL COLIFORM (EMB) COUNTS IN NEW RIVER ESTUARY FROM NOVEMBER 1980 - DECEMBER 1981



192
N
JACKSONVILLE
338
NORTHEAST CREEK
118
644
152
MORGAN BAY
231
506
1780
21
FARNELL BAY
964
677
74
68
STONES BAY
MEAN
S.E.
S.D.
RANGE
KEY
21
SNEADS FERRY
0
SCALE
24000

Salinity, turbidity and water temperature in the New River showed no distinguishable pattern. Figure 12 is the data from Station 5 and the remaining graphs are in Appendix III. No correlation was found between salinity and either the average total coliform ($r=-0.34$, 15df) or average fecal coliform ($r=-0.44$, 10df). No correlation was noted between turbidity and fecal coliform ($r=-0.16$, 6df) or turbidity and total coliform ($r=0.19$, 6df). Rainfall, on the other hand, was highly correlated with total coliform ($r=0.65$, 10df) and with fecal coliform ($r=0.61$, 10df).

Table 4 shows the number and ratio and expected source for fecal coliform counts and fecal streptococci counts. There was a strong correlation ($r= 0.89$, 15df) between the fecal coliform counts and fecal streptococci counts originating from suspected animal sources. Table 5 shows the number, ratio and expected source for fecal coliform counts and Pseudomonas aeruginosa counts. A correlation ($r= 0.72$, 49df) was found between the P. aeruginosa counts and fecal coliform counts originating from suspected human sources.

Rainfall (Table 6) was highest in August (9.65 inches), followed by June and May with 7.85 and 7.14 inches, respectively.

The results of the area use survey are compiled in Table 7. Most responses to question 1 consisted of two or more answers. Recreational fishing and shellfishing has the most participants; recreational boating is the second most popular activity. About 52% of the respondents use the river an average of 5.5 times per month and 30% use it once a month. The average respondent has fished 15.6 years in the area (range 3-35 years) and plans to fish for 20.5 more years.

FIGURE 12 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 5 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

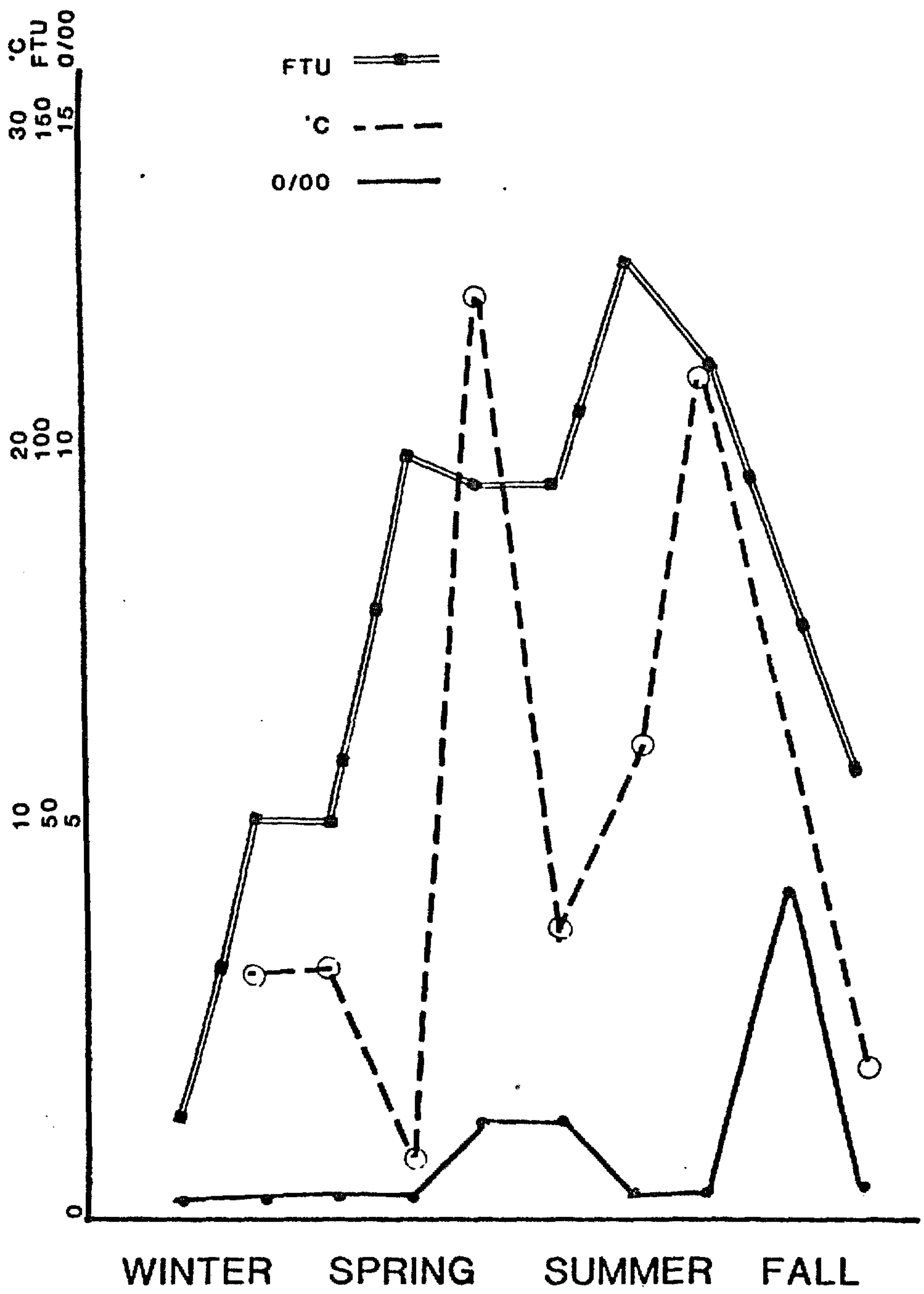

°C
FTU
0/00
30
150
15
20
100
10
10
50
5
0
FTU
'C
0/00
WINTER
SPRING
SUMMER
FALL

TABLE 2 - FECAL STREPTOCOCCI RESULTS

STATION	FECAL COLIFORM /ml	FECAL STREPTOCOCCI /ml	RATIO	Expected source	
				GEOGRAPHIC	BACTERIAL
35	490	130	3.77	human	human
36	130	330	0.39	human	animal*
44	0	45	0.02	animal	animal
52	0	130	0.01	human	animal
93	45	130	0.35	animal	animal*
108	230	1700	0.14	animal	animal
130	45	340	0.13	animal	animal
132	170	1100	0.15	animal	animal
156	0	45	0.02	animal	animal
176	45	0	4.5	human	human
185	3500	78	44.8	animal	human
186	790	330	2.39	animal	human *
247	2400	1300	1.85	animal	human *
249	230	3500	0.06	animal	animal
250	1300	220	5.91	animal	human
262	78	490	0.16	animal	animal
265	170	790	0.22	animal	animal
273	45	170	0.26	animal	animal
274	230	61	3.77	animal	human *
275	78	330	0.24	animal	animal
306	45	18	2.5	animal	human *
315	460	170	2.71	animal	human *
321	78	0	7.8	animal	human
345	1300	3300	0.39	animal	animal
353	490	140	3.5	human	human *
354	2800	16000	0.17	human	animal
355	490	3500	0.14	human	animal

* probable source

TABLE 3 - PSEUDOMONAS AERUGINOSA RESULTS

STATION	FECAL COLIFORM /ml	P. AERUGINOSA /ml	RATIO	Expected source GEOGRAPHIC	Expected source BACTERIAL
1	68	0	6.8	animal	animal
6	78	20	3.9	animal	animal
13	48	0	4.5	animal	animal
32	130	20	6.5	human	animal
34	1300	0	130.0	human	animal
35	490	0	49.0	human	animal
36	130	45	2.89	human	animal*
43	170	20	8.5	animal	animal
51	0	68	0.14	human	human
80	490	20	24.5	animal	animal
91	230	1300	0.17	animal	human
92	68	0	6.8	animal	animal
93	45	0	4.5	animal	animal
95	78	20	3.9	animal	animal
107	430	3500	0.12	animal	human
108	230	0	23.0	animal	animal
109	78	20	3.9	animal	animal
130	45	0	4.5	animal	animal
131	45	0	4.5	animal	animal
140	310	37	8.38	animal	animal
141	1300	0	130.0	animal	animal
142	170	0	17.0	animal	animal
173	310	1300	0.24	animal	human
174	330	20	16.5	animal	animal*
176	45	0	4.5	animal	animal
177	120	20	6.0	animal	animal
184	430	1300	0.33	animal	human
185	3500	0	350.0	animal	animal
186	790	0	79.0	animal	animal
216	310	3500	0.08	human	human
222	78	0	7.8	animal	animal
228	0	45	0.02	animal	human
246	330	110	3.0	animal	animal*
247	2400	0	240.0	animal	animal
248	1200	0	120.0	animal	animal
249	230	0	23.0	animal	animal
250	1300	20	65.0	animal	animal
261	230	18	12.7	animal	animal
263	230	0	23.0	animal	animal
264	140	0	14.0	animal	animal
265	170	0	17.0	animal	animal
266	68	0	6.8	animal	animal
271	230	68	3.38	animal	animal*
272	140	45	3.11	animal	animal*
273	45	0	4.5	animal	animal
274	230	0	23.0	animal	animal

*probable source

TABLE 3 CONTINUED

STATION	FECAL COLIFORM /ml	P. AERUGINOSA /ml	RATIO	Expected source GEOGRAPHIC	Expected source BACTERIAL
275	78	0	7.8	animal	animal
276	110	0	11.0	animal	animal
279	230	68	3.38	animal	animal
306	45	0	4.5	animal	animal
314	230	20	11.5	animal	animal
315	460	0	46.0	animal	animal
316	490	45	10.8	animal	animal
346	230	20	11.5	animal	animal
353	490	0	49.0	human	animal
354	2800	0	280.0	human	animal
355	490	20	24.5	human	animal
360	310	3500	0.09	animal	human
364	45	0	4.5	animal	animal

TABLE 4 - MONTHLY RAINFALL RESULTS

	RAINFALL IN INCHES
November 1980	.39
January 1981	.85
February 1981	1.76
March 1981	1.83
April 1981	.53
May 1981	7.14
June 1981	7.85
July 1981	1.97
August 1981	9.65
September 1981	1.80
October 1981	.81
November 1981	.92

*Data received from Environmental Center, Camp LeJeune, North Carolina and New River Air Station, Jacksonville, North Carolina

TABLE 5 - RESULTS OF 56 SURVEYS RETURNED FROM INDIVIDUAL FISHERMEN

ALL ANSWERS WILL BE KEPT CONFIDENTIAL

1. What is the nature of your activity in the New River area? (check all that apply)
   (15) swimming
   (34) recreational boating
   (50) recreational fishing and/or shellfishing
   (21) commercial fishing and/or shellfishing

2. Approximately how often do you use the New River for your activity?

N-29 (5.5)/month Range 1-15 (✓)/month-8
N=10 (12.1)/year Range 3-50 N/A-2 (✓)/year-5

3. Which general area do you usually use for your activity? (Refer to charts and/or maps)
   (16)A(24)B (24)C (17)D(28)E (28)F (26)G (13)H(21)I (19)J (10)K (18)L (3) M(29)N N/A-1

4. How many years have you fished in this area?(15.6)years N/A 1 Range 3-35

5. For how many years in the future do you expect to fish in the New River area?
   (20.5) years Life-17 Range 1-life

6. If you used a boat on your last trip: Type of boat( )
   Length of boat (17.6)ft. Range 12-21
   Number in party (1.94)males (.6)females Σ = 2.54
   How many days spent in area on trip? (4.8)days N/A 14
   Is this your own boat? (55)yes ( )no N/A-1
   Did (will) you stay overnight in this county as a result of this trip?
   (21)yes (22)no N/A-3
   At a private residence (28)yes (9)no N/A-9
   Public lodging (7)yes (25)no N/A-15

7. Approximately what were the total expenses incurred on this trip in Onslow County? (41)0-$50 (83%) (4) $100-$500 (8%) (1) over $1000 (2%)
   (3)$50-$100 (6%) ( ) $500-$1000 N/A-7

8. Where do you usually launch your boat? (12)private (21%) (33)public (6%) Both-10 (18%) N/A-1

9. What is the approximate value of your boat and gear?
   (2) less than $500 (4%) ( ) $20,000-$50,000
   (14) $500-$1000 (25%) ( ) $50,000-$100,000
   X=3536 (32) $1000-$5000 (57) (1) $100,000-$500,000 (2%)
   (7) $5000-$20,000 (1.25%) ( ) more than $500,000

10. How much have you spent in the last 12 months on boat expenses and gear?
    (6)less than $100 (11%) (2) $5000-$20,000 (4%)
    (29) $100-$500 (52%) ( ) $20,000-$50,000
    (9) $500-$1000 (16%) ( ) more than $50,000
    (10) $1000-$5000 (18%)

11. If fishing...what percent:

sport or recreational	commercial
(2) 0-5 (4%)	(8) 0-5 (51%)
(7) 5-10 (14%)	(3) 5-10 (11%)
(7) 10-25 (14%)	(3) 10-25 (11%)
(5) 25-50 (9%)	(3) 25-50 (11%)
(7) 50-75 (14%)	(3) 50-75 (11%)
(24) 75-100 (16%)	(6) 75-100 (23%)

12. Is your catch sold? (10)yes (19%) (44)no (81%) N/A-2

13. Approximately how many pounds did your total catch weigh during the past 12 months?

(16) 0-100 (29%)
(32) 100-500 (58%)
(3) 500-1000 (5%)
(1) 1000-5000 (2%)
(2) 500-10,000 (4%)
(1) 10,000-20,000 (2%) N/A-1
( ) 20,000-50,000
( ) more than 50,000

14. Is your fishing activity for a particular species? (17) yes (31%) (37) no (69%) N/A-2

15. What type of fishing gear and method do you usually use? (Check all that apply)

gear
(43) pole and line
(47) gill net
(11) seine
(14) cast net (bait)
(20) rake, tong
(27) gig
(3) dredge
(2) other Crab Pot
(1) Eel Pot

method
(23) trawling
(29) still fishing
(39) drifting
(36) casting
(1) other Shrimp Trawl (20 ft net)
(1) Setting net

16. If you knew in advance that you wouldn't have caught anything in the bay area today, how much money would you have spent on some other activity in Onslow County?

(31) $0-10 (63%)
(15) $10-$50 (31%)
(1) $50-$100 (2%)
(1) $100-$300 (2%)
( ) $300-$500 N/A-7
(1) more than $500 (2%)

17. What is your occupation? ( )

18. Would you indicate which catagory most closely corresponds to your income for the past 12 months?

(6) less than $5000 (12%)
(7) $5000-$10,000 (13%)
(16) $10,000-$15,000 (31%)
(9) $15,000-$20,000 (17%)
(8) $20,000-$30,000 (15%)
(5) $30,000-$40,000 (9%)
(1) $40,000-$50,000 (2%) N/A-4
( ) more than $50,000

19. Comments on improving the use of the New River

6. Type of boat

Skiff - 13
Fiberglass - 3
Trihull - 2
Wood - 2
Allendale - 2
Aluminum - 2
Bass - 2
Well boat
Open whaler
Cruiser
McKee craft
Phillips
Dixie
I-O
Manatee
Porter
Outboard
Canoe
Atlantic
Trawler (80 ft.)
Pleasure

N/A - 16

17 Occupation

Veterinarian
Dentist
Principal
Teacher
Civil Service - 2
Salesman - 2
Manager - radio station
Office Manager
Plant manager - Oil Co.
Insurance agent
Parts manager
Life insurance salesman
Merchant
Store clerk
Production leader
N.C. Marine Fisheries
Telephone Co. - 4
Construction worker - 2
Fireman
Industry
Lineman
Electrician
Courier
Welder
Painter
Heavy equipment operator
Refrigeration
General maintenance person
DVAA assistant
Auto mechanic
Bait and tackle shop
Body repairman
Fishermen - 3
Farmer
Unspecified - 5
Student
Unemployed
Retired - 9

N/A - 2

The average boat, valued at $3,536, is 17.6 feet long and carries an average party of 1.94 males and 0.6 females. The average trip is 4.8 days and at least half respondents either will live or stay overnight in the county. Of the 56 respondents, 55 own their boats. Public boat ramps are used by 60% of the respondents, 21% prefer private ramps and 18% use both types. Over 80% of the respondents spent less than $50 per trip. In the past twelve months, those polled (52%) spent an average of $100-500 on boat expenses and gear.

Sport fishermen comprised 46% of the respondents and only 19% sell their catch. Thirty-two of 52 (58%) caught between 100-500 pounds of fish this year with only one over 10,000 pounds. Fishermen were generally after no specific catch (69%). Gill nets and pole and line are the predominant gear with drifting and casting being the method most often used in the river.

Although it is difficult to determine the amount of money spent in the county on a trip, most of the respondents (63%) felt that they would have spent up to $10 in Onslow County if they knew they would not catch anything on the trip. The occupation of the respondents is diverse. Of the respondents, 31% had incomes between $10,000 -15,000 and only one exceeds $40,000.

DISCUSSION AND CONCLUSIONS

In this study we tried to determine the impact of fecal pollution on the New River Estuary. We attempted to assess the coliform bacteria distribution and tried to define point and non-point sources of pollution in the estuary. During the 1980-1981 sample year, high coliform levels occurred around the city of Jacksonville, Northeast Creek and in the head waters of all the smaller creeks; lower levels occured in the bay. We postulated at the beginning of the study and our data showed that the high coliform counts around Jacksonville are du to increased population. The reduced numbers in the bay areas are p ably due to high tidal fluxuation and greater depth of the water. A her possible explanation of the low coliform counts in the bay i debilitation and dilution of the bacteria . When the bacteria enter salt water, they become stressed, will not grow on selective media and are out-competed by the other bacteria (Dawe and Penrose, 1978).

The bacterial composition of the sewage outfalls in the New River were examined. Fecal and total coliform counts were below the EPA-acceptable limits of 79 MPN for Class C waters (EPA,1978) in all areas except Wilson Bay. Class C water is acceptable for sewage outfalls, fishing, agriculture and secondary recreation but not for drinking, food preparation or primary recreation. In Wilson Bay, increased fecal coliform counts are attributed to the resuspension of bottom sediments by current agitation and a concomitant release of sediment-bound fecal coliforms. An indepth study of sediments in this bay is highly recommended.

Our data indicate that the outfalls are not the primary source of coliform pollution in the river and that the present discharge system is acceptable. Any large increase in the human population, such as would happen with expanded land development, could tax the sewage system. Growth in this area should be accompanied by evaluation of the capability of all existing sewage disposal and septic systems handling wastes. Sources contributing significantly to the high coliform counts in the river are land runoff, wildlife and sanitary landfills (Northeast Creek). Salinities were poorly correlated with the total coliform and fecal coliform numbers found at stations throughout the estuary thus, salinity was not thought to be important in this estuary. Similar results were found with temperature, but rainfall showed a relationship. We therefore feel that rain is the main influence on coliform counts in this estuary.

We think that sources other than sewage outfalls are the main cause of coliform pollution in the New River. It appears that agricultural use, extensive forest land and the presence of the Camp Lejeune Marine Base effect bacterial densities in the bay. Specific local activities observed during the study which are thought to influence the bacterial densities include:

1) U.S. Marine field exercises
2) Extensive deer herds
3) Domestic animals in the agricultural areas
4) Increased runoff volume as a result of the removal of natural ground cover for construction activities.

The results of the analysis for fecal streptococci and _Pseudomonas aeruginosa_ support this theory. If the fecal streptococci to fecal coliform ratio is greater than four, it indicates domestic sewage and ratios of 0.6 indicate animal-related coliforms. This ratio indicates the source of coliforms in the New River is probably animal (Table 3).

In this study of the New River, our data resembles Cabelli's (1976) data from Lake Michigan. In both the New River and Lake Michigan, the *Pseudomonas aeruginosa* counts when related to fecal coliform indicate the pollution source. If *Pseudomonas aeruginosa* is low and fecal coliform is high, the source is again believed to be animal. Table 4 further supports the hypothesis that the New River coliform is of animal origin.

In this study, the total coliform counts rise to a high during February then diminish to a low in April. The counts rise again in June, drop in July and climb in August. The counts remain high in the fall and drop as winter begins. This pattern holds true for all areas except Stones Bay, where the counts are low throughout the year with a peak in late summer and again in the late fall. The fecal coliform counts follow the same pattern as the total coliform throughout the year. The only major exception is in Stones Bay in mid fall when the counts rise and then drop again in late October before they rise in late November. This seasonal change did not appear to be related to temperature, that is no correlation was found, however, it was related to the amount of rainfall. During the sample year, the highest monthly rainfall accumulations were in May, June and August with a correspondingly high bacterial count due to increased land runoff. This pattern does not apply to Stones Bay where the dilution is already high so the increased runoff has little or no effect.

The magnitude and value of assorted water-related activities on the New River is unknown. However, undesirable levels of fecal coliform in the New River would certainly create countywide economical and sociological problems. The impact of closing of the river to commercial and recreational activities is presently unknown. Therefore, a survey was utilized to evaluate the potential economic losses of closing the river to Onslow County residents. Out of 1200 potential users, the 56 (5%) who responded to the questionnaire were used to give an indication of the use of the river. The majority of the respondents use the river for commercial or recreational fishing. Half of the respondents use the river an average of 5.5 times per month and 17% use it one time per month. Using these percentages we estimated that approximately 1000 persons use the river at least once per month.

The New River estuary has been used extensively for recreational boating, crabbing and fishing and as the local population increases, recreational use of the area will also likely increase. More than 20,000 people per year use the Camp Lejeune Marina alone. Based upon a recent Jacksonville survey, which has been accepted as representative of Onslow County (Horace Mann, 1981) at least 14% of the population is involved in boating and another 12.5% would like to do so. Additionally, 34.5% of the population of Jacksonville actively fish on the New River, with an additional 14.3% desiring to do so. Finally the seafood harvesting and processing industries add approximately $10,000,000 to the economy of Onslow County (CAMA, 1980).

Any increase in the present high bacterial levels, and in fact, the present level of contamination, would be detrimental to recreational and commercial uses of the New River. For example, during the last part of April, 1981, the river was closed to human immersion, fishing and crabbing by order of the N.C. Shellfish Sanitation Department. This resulted in decreased public spending for recreational activities and loss of income to local commercial fishermen.

Analysis of field and laboratory data collected during this study on bacteriological contamination of the New River, Onslow County, N.C., has led to the following conclusions:

1) High total coliform and fecal coliform counts appear to be concentrated around the populated areas of Jacksonville City and in Northeast, Frenchs Creeks and in Wilson Bay.
2) Most coliform counts appeared to be from non-point sources and could be attributable to run-off from agricultural pastures, wildlife and sanitary landfills.
3) Fecal streptococci and Pseudomonas aeruginosa data indicate that the non-point coliform pollution is most likely of an animal origin.
4) Seasonal patterns of coliform distribution showed peaks in February, June and August, probably due to increased rainfall during these months.
5) Increased counts of coliform bacteria will be detrimental to recreational and commercial use of the New River watershed area, while decreased counts will tend to benefit its socio-economic growth and stability.

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Key Code to Appendix I

Sta	*Station Number Identifer Code*
S	*Salinity (0/00)*
Tur	*Turbidity (FTU)*
At	*Air Temperature (°C)*
Wt	*Water Temperature (°C)*
Lt	*Lauryl Tryptose broth*
BGB	*Brillant Green Bile broth*
EC	*EC broth*
EMB	*Eosine Methylene Blue Agar*
Asp	*Asparagine broth*
Act	*Acetamide Agar*
AZD	*Azide Dextrose broth*
EVA	*Ethyl Violet Azide broth*
Vib	*Vibrio sp.*
D.O.	*Dissolved Oxygen (ppm)*

Appendix I is summary data from November 30, 1980 to December 7, 1981, New River Estuary

APPENDIX I

	#	Sta	S	Tur	At	Wt	Lt	BGB	EC	ENB	Asp	Act	AZD	FVA	Vib	[illegible]
A	1	SCB 12/7$_{5}$I	0	45	13	9.0	490	220	68	110	45	0	220	93	0	[illegible]
	2	SCB 1/9$_{1}$I	0	95cm	8	5.2	2400	790	490	270	-	-	-	-	-	[illegible]
	3	SCB 3/18$_{12}$I	1	30	19	13	320	110	45	68	-	-	-	-	-	-
	4	SCB 6/11$_{13}$I	0	110	28	39	9200	3500	78	68	-	-	-	-	-	-
	5	SCB 7/10$_{14}$I	1	55	32	30.5	790	490	100	68	-	-	-	-	-	[illegible]
	6	SCB 8/29$_{10}$I	0	26	30	23	2800	1800	78	92	92	20	-	-	-	4.8
	7	SCB 11/30$_{1}$I	0	45	0.5	9.5	3200	920	170	540	-	-	-	-	-	-
	8	SCB 3/18$_{11}$I	3	30	18	12	490	110	78	45	-	-	-	-	-	-
	9	SCB 6/11$_{12}$I	0	79	38	29	480	340	45	140	-	-	-	-	-	-
	10	SCB 7/10$_{13}$I	1	45	32	30	5400	5400	68	130	-	-	-	-	-	[illegible]
	11	SCB 6/11$_{11}$I	0	105	37	27	5400	1100	130	210	-	-	-	-	-	-
	12	SCB 7/10$_{12}$I	1	45	33	30	790	790	20	68	-	-	-	-	-	6.8
	13	SCB 8/29$_{9}$I	0	30	29	23	790	490	45	0	0	0	-	-	-	4.5
	14	SCB 1/9$_{2}$I	0	61	8	5.2	3500	1700	230	490	-	-	-	-	-	-
	15	SCB 3/18$_{13}$I	4	30	20	11.5	790	490	45	78	-	-	-	-	-	-
	16	SCB 8/29$_{8}$I	0	55	35	28	16000	5400	68	68	-	-	-	-	-	-
	17	SCB 7/10$_{11}$I	4	75	33	34	24000	5400	45	68	-	-	-	-	-	6.7
	18	SCB 8/29$_{8}$I	0	30	30	24	1700	790	20	83	0	0	-	-	-	5.1
	19	SCB 11/30$_{2}$I	0	18	18	7.6	3200	3200	920	29	-	-	-	-	-	-
	20	SCB 1/9$_{4}$I	0	-	6	5	3200	3200	1100	1400	-	-	-	-	-	11.0
	21	SCB 3/18$_{14}$I	2	38	20	11	1300	110	40	20	-	-	-	-	-	-
B	22	SCB 1/9$_{5}$I	0	58	4.5	4.2	9200	3500	460	170	-	-	-	-	-	10.8
	23	SCB 2/28$_{1}$I	2	40	19	11	790	330	130	330	-	-	-	-	-	-
	24	SCB 3/18$_{9}$I	8	25	18	12	1700	45	40	0	-	-	-	-	-	-
	25	SCB 3/18$_{10}$I	6	35	18	12	220	45	20	20	-	-	-	-	-	-
	26	SCB 5/13$_{1}$I	0	-	24	23	24000	24000	16000	320	-	-	-	-	-	-
	27	SCB 6/11$_{9}$I	0	90	34	28	2400	790	20	130	-	-	-	-	-	-
	28	SCB 6/30$_{1}$I	3	70	28	27	2400	2400	1300	270	-	-	-	-	-	-
	29	SCB 7/10$_{10}$I	4	35	33.5	31.5	9200	260	0	40	-	-	-	-	-	6.6
	30	SCB 7/24$_{1}$I	8	20	30	30	1600	5400	230	20	1300	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	DGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
31	SCB $8/20_{1}I$	2	75	23	22	24000	24000	230	140	700	170	-	-	-	7.5
32	SCB $8/29_{11}I$	2	32	29	24.5	1300	790	130	130	45	20	-	-	-	4.9
33	SCB $9/25_{1}I$	5	-	25	21	3500	1300	20	120	0	0	700	20	1	-
34	SCB $10/12_{1}I$	4	-	24	16	3500	3500	1300	1700	0	0	1300	1300	2	-
35	SCB $10/31_{0}I$	21	110	17.5	16	1700	1700	490	1700	0	0	2400	130	TNTC	-
36	SCB $11/15_{1}I$	18	26	15	11	16000	3500	130	330	45	45	490	330	15	-
37	SCB $12/7_{4}I$	12	40	14.0	9.0	78	45	0	0	0	0	0	0	0	19
C 38	SCB $11/30_{3}I$	2	55	2.2	8.6	3200	3200	540	52	-	-	-	-	-	72
39	SCB $1/9_{6}I$	0	55	5	4.3	9200	5400	790	170	-	-	-	-	-	11.7
40	SCB $3/18_{8}I$	8	30	17	12	490	170	45	68	-	-	-	-	-	-
41	SCB $6/11_{8}I$	0	105	34	29	5400	3500	45	170	-	-	-	-	-	-
42	SCB $7/10_{9}I$	5	35	33.5	31	3500	490	230	230	-	-	-	-	-	6.5
43	SCB $8/29_{6}I$	0	29	28	25	2400	1300	170	93	45	20	-	-	-	5.2
44	SCB $12/7_{3}I$	15	20	15	9	130	130	0	45	0	0	78	45	0	1[illegible]
45	SCB $1/9_{7}I$	0	58	5.5	4	32000	2400	330	170	-	-	-	-	-	-
46	SCB $3/18_{6}I$	9	35	17	11	1100	1100	140	170	-	-	-	-	-	-
47	SCB $3/18_{7}I$	8	33	17	11	490	230	45	130	-	-	-	-	-	-
48	SCB $6/11_{6}I$	1	50	36	29	24000	16000	5400	450	-	-	-	-	-	-
49	SCB $7/10_{7}I$	8	45	32	30.5	490	170	0	40	-	-	-	-	-	6.6
50	SCB $7/10_{8}I$	9	35	33	31	790	790	20	20	-	-	-	-	-	6.6
51	SCB $8/29_{5}I$	4	28	28	26	700	460	0	40	68	68	-	-	-	6.0
52	SCB $12/7_{2}I$	9	55	15.5	9.5	330	170	0	78	20	0	230	130	0	19
53	SCB $11/30_{4}I$	7	50	6.7	8.8	350	180	130	280	-	-	-	-	-	87
54	SCB $6/11_{5}I$	1	80	36	28	2400	1300	78	130	-	-	-	-	-	-
55	SCB $8/29_{4}I$	4	30	30	26	330	330	0	0	20	0	-	-	-	5.3
56	SCB $7/10_{6}I$	12	30	31.5	31	490	330	20	20	-	-	-	-	-	6.6
57	SCB $4/15_{1}I$	10	10	19	22	490	140	0	40	-	-	-	-	-	-
58	SCB $10/31_{2}I$	18	85	17	16.5	45	45	0	0	0	0	78	0	TNTC	-
59	SCB $11/15_{2}I$	23	17	15	12	2200	1300	170	340	220	220	220	140	8	-
60	SCB $1/9_{8}I$	6	60	5.5	5.1	5400	330	50	80	-	-	-	-	-	14.5

APPENDIX I

#	Sta	C	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
61	SCB 3/18$_{5}$I	15	21	17	11	110	110	110	68	-	-	-	-	-	-
62	SCB 8/29$_{2}$I	4	70	39	29	9200	3500	68	140	-	-	-	-	-	-
63	SCB 8/29$_{2}$I	3	26	27	25	1100	790	20	61	45	45	-	-	-	5.9
E 64	SCB 7/10$_{5}$I	12	30	32	30.5	0	0	0	0	-	-	-	-	-	6.7
65	SCB 12/7$_{1}$I	18	20	14	9.5	20	20	0	0	0	0	20	0	0	16
F 66	SCB 3/18$_{3}$II	14	10	17	11	170	68	68	40	-	-	-	-	-	-
67	SCB 6/11$_{3}$II	3	55	32	30	1300	1300	45	78	-	-	-	-	-	-
68	SCB 7/10$_{3}$II	7	20	33	31.5	110	68	0	45	-	-	-	-	-	6.6
69	SCB 8/29$_{2}$II	10	15	27	25.5	3500	1100	45	93	45	45	-	-	-	6.3
70	SCB 4/15$_{1}$II	4	12	19	18	2200	950	0	640	-	-	-	-	-	-
71	SCB 2/28$_{3}$II	0	20	18	11	270	170	20	110	-	-	-	-	-	-
72	SCB 1/9$_{3}$II	-	-	-	4.2	330	230	0	50	-	-	-	-	-	-
73	SCB 3/18$_{4}$II	12	16	16	11	45	20	0	20	-	-	-	-	-	-
74	SCB 3/18$_{5}$II	12	15	16	11	0	0	0	0	-	-	-	-	-	-
75	SCB 6/11$_{2}$II	7	37	35	29	330	130	20	45	-	-	-	-	-	-
76	SCB 7/10$_{4}$II	10	35	33	30	130	130	0	78	-	-	-	-	-	6.6
77	SCB 7/24$_{3}$II	0	15	27	22	24000	16000	790	61	-	-	-	-	-	-
78	SCB 6/11$_{5}$II	3	55	32	30	1300	1300	45	78	-	-	-	-	-	-
79	SCB 7/10$_{5}$II	9	30	32	31.5	170	68	0	18	-	-	-	-	-	6.5
80	SCB 8/29$_{4}$II	9	18	27	25	3500	3500	490	490	40	20	-	-	-	6.2
81	SCB 1/9$_{4}$II	-	-	-	5.2	3500	490	50	40	-	-	-	-	-	-
82	SCB 2/4$_{1}$II	0	85	-1	4	24000	24000	24000	-	-	-	-	-	-	-
83	SCB 2/28$_{2}$II	5	45	19	13.5	1300	490	78	220	-	-	-	-	-	-
84	SCB 3/18$_{6}$II	6	17	16	11.5	490	490	20	220	-	-	-	-	-	-
85	SCB 4/15$_{2}$II	9	5	19	23	5400	3500	0	74	-	-	-	-	-	-
86	SCB 5/13$_{3}$II	4	-	27	26	9200	9200	330	200	-	-	-	-	-	-
87	SCB 6/11$_{6}$II	0	80	33	29	5400	1400	230	130	-	-	-	-	-	-
88	SCB 6/30$_{4}$II	6	55	29	27	24000	3400	110	93	-	-	-	-	-	-
89	SCB 7/10$_{6}$II	7	30	32	31.5	3500	1100	78	68	-	-	-	-	-	6.6
90	SCB 7/24$_{1}$II	8	35	27	30	24000	9200	230	0	2400	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
91	SCB 8/20$_{5}$II	1	190	22	22	24000	24000	230	380	1300	1300	-	-	-	5.3
92	SCB 9/25$_{2}$II	5	-	25	23	1700	790	68	40	0	0	230	45	42	15.5
93	SCB 10/12$_{1}$II	14	-	24.5	19	9200	3500	45	110	170	0	330	130	0	-
94	SCB 10/31$_{1}$II	19	160	21	16	110	110	20	110	0	0	330	0	TNTC	-
95	SCB 11/15$_{3}$II	20	29	17	12	9200	3500	78	330	40	20	140	93	8	-
96	SCB 1/21$_{2}$II	0	5	10	8	16000	9200	790	450	-	-	-	-	-	-
97	SCB 5/27$_{5}$II	1	60	24	20	1700	1300	230	330	-	-	-	-	-	-
98	SCB 1/21$_{3}$II	0	30	10	8	230	230	230	230	-	-	-	-	-	-
99	SCB 5/27$_{4}$II	1	50	24	20	2400	790	78	170	-	-	-	-	-	-
100	SCB 5/27$_{3}$II	1	120	23	20	5400	3500	1300	790	-	-	-	-	-	-
101	SCB 1/21$_{4}$II	0	165	10	9	32000	16000	5400	1400	-	-	-	-	-	-
102	SCB 5/27$_{2}$II	2	85	23	20	2200	640	0	0	-	-	-	-	-	-
103	SCB 2/4$_{2}$II	11	45	-2	7	24000	24000	3500	810	-	-	-	-	-	-
104	SCB 4/15$_{8}$II	15	0	21	23	230	20	0	20	-	-	-	-	-	-
105	SCB 5/27$_{6}$II	20	40	22	24	130	78	0	20	-	-	-	-	-	-
106	SCB 7/24$_{1}$II	14	10	18.5	30	700	700	20	0	-	-	-	-	-	-
107	SCB 8/20$_{4}$II	10	50	22	23.5	24000	24000	430	200	16000	3500	-	-	-	6.2
108	SCB 10/31$_{2}$II	5	110	20	16.5	1300	490	230	490	0	0	1700	1700	7	-
109	SCB 11/15$_{2}$II	21	18	15	10	790	490	78	170	40	20	79	78	1	-
110	SCB 2/28$_{4}$II	12	30	19	12	130	45	20	45	-	-	-	-	-	14
G 111	SCB 3/18$_{2}$II	13	19	13	10.5	130	130	20	130	-	-	-	-	-	-
112	SCB 6/11$_{1}$I	5	50	37.5	28	3500	120	0	18	-	-	-	-	-	-
113	SCB 7/10$_{1}$I	13	20	30	30	45	20	0	20	-	-	-	-	-	6.5
114	SCB 8/29$_{1}$I	5	20	27	25.5	490	230	0	78	20	0	-	-	-	8.3
D 115	SCB 11/30$_{5}$I	5	45	8.4	6.2	1600	1600	350	920	-	-	-	-	-	69
116	SCB 1/9$_{10}$I	0	28	5	2.8	5400	200	20	60	-	-	-	-	-	11.4
117	SCB 3/18$_{1}$I	10	15	13	11	460	45	0	45	-	-	-	-	-	-
118	SCB 7/10$_{2}$I	9	20	30.5	30	790	490	20	110	-	-	-	-	-	6.5
119	SCB 6/29$_{[illegible]}$I	3	26	27	25	1100	790	20	61	45	45	-	-	-	5.9
120	SCB 12/7$_{1}$I	18	[illegible]	14.[illegible]	9.5	20	20	0	0	0	0	20	0	0	16

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	A7D	EVA	Vib	D.O
121	SCB $3/18_2$I	6	15	12	17	130	45	0	45	-	-	-	-	-	-
122	SCB $6/11_2$I	2	60	39	30	1300	79	20	37	-	-	-	-	-	-
123	SCB $7/10_3$I	8	35	31	30	2400	1300	78	78	-	-	-	-	-	6.6
124	SCB $3/18_3$I	4	16	16	1.5	270	61	0	20	-	-	-	-	-	-
125	SCB $6/11_3$I	1	60	39	29	1300	490	68	40	-	-	-	-	-	-
126	SCB $7/10_4$I	6	35	31.5	30	3500	3500	45	120	-	-	-	-	-	6.7
127	SCB $5/27_3$I	1	60	22	20	790	490	40	68	-	-	-	-	-	-
128	SCB $5/27_2$I	1	50	22	20	2400	1300	230	490	-	-	-	-	-	-
129	SCB $8/20_2$I	1	120	23	21	24000	24000	230	92	9200	3500	-	-	-	5
130	SCB $10/12_2$I	0	-	27	16.5	3500	3500	45	92	790	0	24000	340	90/10	-
131	SCB $10/31_1$I	0	55	18	16	93	68	45	68	0	0	0	78	0	-
132	SCB $11/15_3$I	1	22	16	12	3500	2400	170	170	490	93	5400	1100	0	-
133	SCB $1/17_1$I	0	-	2	2	1700	220	170	170	-	-	-	-	-	-
134	SCB $1/21_1$I	0	30	10	10	3500	1300	790	1300	-	-	-	-	-	-
135	SCB $2/28_2$I	0	30	22	10	-	-	-	-	-	-	-	-	-	-
136	SCB $4/29_1$I	0	5	-	20	490	170	20	68	-	-	-	-	-	-
137	SCB $5/27_1$I	1	120	24	19	2400	2400	790	1300	-	-	-	-	-	-
138	SCB $4/30_2$I	1	35	29	19	5400	2200	1100	330	-	-	-	-	-	-
139	SCB $7/24_2$I	0	55	30	25	2800	2800	330	460	220	-	-	-	-	-
140	SCB $8/20_3$I	0	110	23	225	24000	16000	310	440	37	37	-	-	-	6
141	SCB $10/12_1$I	4	-	23	16	3500	3500	1300	1700	0	0	1300	1300	2	-
142	SCB $4/15_4$I	0	16	15	11	16000	5400	170	5400	0	0	110	110	3	-
G 143	SCB $2/4_3$II	0	20	-2	4.5	24000	24000	720	810	-	-	-	-	-	-
144	SCB $4/15_7$II	0	10	23	20	2400	1300	0	170	-	-	-	-	-	-
145	SCB $5/27_7$II	1	50	23	21	5400	5400	330	220	-	-	-	-	-	-
146	SCB $7/24_3$II	0	15	27	22	24000	16000	790	61	-	-	-	-	-	-
147	SCB $2/4_4$II	0	10	0	5	24000	720	150	190	-	-	-	-	-	-
148	SCB $4/15_6$II	0	17	23	21	2200	2200	0	1100	-	-	-	-	-	-
149	SCB$5/27_8$II	1	35	23	23	1100	790	490	490	-	-	-	-	-	-
150	SCB $7/24_4$II	0	20	28	26	24000	16000	1300	36	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
151	SCB 2/28$_5$II	12	30	18	11	68	45	45	45	-	-	-	-	-	-
152	SCB 3/18$_1$II	13	17	13	11	20	20	20	0	-	-	-	-	-	-
153	SCB 6/11$_2$II	7	39	35	29	330	130	20	45	-	-	-	-	-	-
154	SCB 7/10$_2$II	0	25	27	25	24000	24000	1300	200	-	-	-	-	-	-
155	SCB 8/29$_1$II	9	17	27	25.5	78	78	0	78	-	-	-	-	-	9
156	SCB 9/12$_2$II	10	5	27	25	220	130	0	20	20	20	230	45	0	6.4
157	SCB 2/28$_2$II	5	45	19	13.5	1300	490	78	220	-	-	-	-	-	-
158	SCB 3/28$_5$II	175	-	19	11	2200	2200	0	2200	-	-	-	-	-	-
159	SCB 4/29$_1$II	17	3	25	21.5	130	0	0	0	-	-	-	-	-	-
160	SCB 11/30$_1$II	12	50	9	8.4	3200	3200	3200	50	-	-	-	-	-	-
161	SCB 2/4$_4$II	4	50	0	6.5	24000	24000	810	810	-	-	-	-	-	-
162	SCB 2/4$_9$II	4	50	1	6	24000	24000	720	810	-	-	-	-	-	-
163	SCB 3/28$_1$II	10	-	12	13	460	460	20	68	-	-	-	-	-	-
164	SCB 3/28$_6$II	15	-	22	16	490	220	20	220	-	-	-	-	-	-
165	SCB 4/15$_5$II	15	15	20	22	230	130	0	45	-	-	-	-	-	-
166	SCB 5/13$_1$II	9	-	26	27	490	330	0	45	-	-	-	-	-	-
167	SCB 5/13$_2$II	4	-	24	24	210	210	20	40	-	-	-	-	-	-
168	SCB 5/27$_9$II	20	20	24	25	20	20	0	20	-	-	-	-	-	-
169	SCB 6/11$_1$II	4	40	32	31	490	230	45	78	-	-	-	-	-	-
170	SCB 6/30$_1$II	10	50	23	27	490	330	0	45	-	-	-	-	-	-
171	SCB 7/10$_1$II	8	20	29	31	230	230	0	0	-	-	-	-	-	7.4
172	SCB 7/24$_5$II	12	15	27	29	1700	460	78	0	3400	-	-	-	-	-
173	SCB 8/20$_1$II	4	70	21	22	24000	16000	310	61	1300	1300	-	-	-	5.5
174	SCB 8/29$_5$II	10	10	30	25	5400	470	330	170	45	20	-	-	-	5.3
175	SCB 9/12$_1$II	10	10	27	26	2400	490	20	20	45	45	460	20	TNTC	6.5
176	SCB 10/31$_3$II	19	70	20	17	220	220	45	140	0	0	130	0	100	-
177	SCB 11/15$_1$II	21	18	16	10	3500	3500	120	210	45	20	490	68	0	-
178	SCB 2/4$_7$II	2	46	2	6.5	24000	24000	640	24000	-	-	-	-	-	-
179	SCB 2/28$_1$II	0	30	15	11	230	230	78	230	-	-	-	-	-	-
180	SCB 4/15$_3$II	4	17	22	20	9200	9200	0	5400	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	I.t	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
181	SCB 4/29$_3$II	4	8	25	23.5	330	330	130	130	-	-	-	-	-	-
182	SCB 6/30$_3$II	7	50	23	26	24000	24000	1300	410	-	-	-	-	-	-
183	SCB 7/24$_6$II	1	50	29	27	24000	4300	230	0	2400	-	-	-	-	-
184	SCB 8/20$_2$II	1	100	21	22	24000	24000	430	210	3500	1300	-	-	-	5.4
185	SCB 9/25$_1$II	1	-	27	21	16000	16000	3500	16000	0	0	230	78	1	-
186	SCB 10/12$_2$II	10	-	25	20	16000	9200	790	470	92	0	330	330	47	-
187	SCB 2/4$_6$II	0	22	1	5	24000	24000	720	810	-	-	-	-	-	-
188	SCB 4/15$_1$II	4	12	19	18	2200	950	0	640	-	-	-	-	-	-
189	SCB 6/30$_5$II	0	60	26	23	5400	5400	1300	2400	-	-	-	-	-	-
G 200	SCB 2/28$_4$II	12	30	19	12	130	45	20	45	-	-	-	-	-	-
201	SCB 2/28$_3$II	0	20	18	11	270	170	20	110	-	-	-	-	-	-
202	SCB 3/28$_1$II	10	-	12	13	460	460	20	68	-	-	-	-	-	-
203	SCB 4/29$_2$II	19	8	25	21	1700	1700	1700	0	-	-	-	-	-	-
204	SCB 6/30$_2$II	10	35	23	26.5	640	210	20	20	-	-	-	-	-	-
205	SCB 12/7$_1$II	22	35	14	8.5	0	0	0	0	0	0	0	0	0	15
I 206	SCB 9/12$_1$III	11	10	26	26	220	45	0	45	0	0	230	20	+	6.9
207	SCB 12/7$_6$ III	22	12	13.5	9	20	20	0	0	0	0	230	0	0	17
208	SCB 11/30$_2$III	22	-	8.8	9	33	17	8	11	-	-	-	-	-	-
209	SCB 3/28$_1$III	21	-	13	12.5	78	78	0	78	-	-	-	-	-	-
210	SCB 3/28$_8$III	19	-	18	11.5	0	0	0	0	-	-	-	-	-	-
211	SCB 4/29$_1$III	20	0	25	22	78	0	0	0	-	-	-	-	-	-
212	SCB 6/30$_1$III	12	25	22.5	26	170	45	20	20	-	-	-	-	-	-
213	SCB 2/4$_1$III	0	88	-1.5	4	24000	24000	320	24000	-	-	-	-	-	-
214	SCB 5/13$_1$III	0	-	26	25	460	68	0	20	-	-	-	-	-	-
215	SCB 7/24$_1$III	0	20	27	27	9200	9200	790	68	-	-	-	-	-	-
216	SCB 8/20$_1$III	0	320	22	22	24000	24000	310	61	3000	3500	-	-	-	4.8
217	SCB 11/30$_1$III	-	-	8.5	9	5	2	2	2	-	-	-	-	-	-
218	SCB 2/28$_3$III	15	30	16	11	78	45	20	20	-	-	-	-	-	-
219	SCB 2/28$_5$III	15	15	18	13	20	0	0	0	-	-	-	-	-	-
220	SCB 3/28$_7$III	21.5	-	20	15.5	45	45	18	45	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BCB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
221	SCB 6/30$_2$III	13	40	26	26	490	330	0	0	-	-	-	-	-	-
222	SCB 9/12$_2$III	115	7	28	26.5	220	170	78	78	18	0	230	0	+	6.2
223	SCB 12/7$_5$III	22	10	12.5	8.5	0	0	0	0	0	0	0	0	0	16
K 224	SCB 2/28$_2$III	15	22	15	13	0	0	0	0	-	-	-	-	-	-
225	SCB 2/28$_6$III	17	25	18	13	0	0	0	0	-	-	-	-	-	-
226	SCB 3/28$_2$III	18	-	13	12.2	230	130	45	130	-	-	-	-	-	-
227	SCB 4/29$_2$III	21	1	26	22	230	0	0	0	-	-	-	-	-	-
228	SCB 9/12$_3$III	11	8	27	16	490	220	0	68	230	45	130	20	+/+	6.6
229	SCB 12/7$_4$III	25	10	12	8	0	0	0	0	0	0	0	0	0	14
230	SCB 11/30$_1$IV	4	75	8.8	9	1600	1600	540	920	-	-	-	-	-	-
231	SCB 2/28$_8$IV	14	20	17	14	20	18	0	18	-	-	-	-	-	-
232	SCB 2/28$_9$IV	12	15	16	14	140	45	45	20	-	-	-	-	-	-
233	SCB 3/28$_1$IV	10	-	15	13.5	1800	1800	18	1800	-	-	-	-	-	-
234	SCB 4/29$_1$IV	20	5	26	22	230	0	0	0	-	-	-	-	-	-
235	SCB 6/30$_3$IV	15	35	29	26	950	160	0	0	-	-	-	-	-	-
236	SCB 9/12$_1$IV	12	6	27	27	260	110	20	45	230	20	230	45	+/	-
237	SCB 12/7$_1$IV	12	6	27	27	260	110	20	45	230	20	230	45	+/	
238	SCB 2/4$_4$IV	0	30	-1.5	2	24000	24000	320	320	-	-	-	-	-	-
239	SCB 2/28$_3$IV	1	35	11	8.5	460	460	330	130	-	-	-	-	-	-
240	SCB 2/28$_6$IV	0	45	20	11	-	-	-	-	-	-	-	-	-	-
241	SCB 4/15$_1$IV	0	5	21	18	400	330	0	330	-	-	-	-	-	-
242	SCB 5/13$_3$IV	0	-	26	19	2200	2200	110	110	-	-	-	-	-	-
243	SCB 6/30$_2$IV	0	45	35	21	5400	2200	230	700	-	-	-	-	-	-
244	SCB 7/24$_1$IV	0	70	28	24	2800	950	330	230	410	-	-	-	-	-
245	SCB 8/20$_4$IV	0	210	22	22	24000	24000	580	140	2400	2400	-	-	-	5.4
246	SCB 9/12$_2$IV	1	12	30	21	9200	3500	330	460	2400	110	330	330	0	-
247	SCB 9/25$_4$IV	0	-	27	13.5	2400	2400	2400	2400	0	-	3500	1300	0	7
248	SCB 10/12$_1$IV	0	-	16	24	1200	1200	330	950	18	0	3000	470	0	-
249	SCB 10/31$_1$IV	1	100	21	16	3500	240	230	240	0	0	3500	3500	0	-
250	SCB 11/15$_3$IV	0	28	15	10	3500	1300	1300	1200	78	20	2400	220	0	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	FVA	Vib	D.O
251	SCB 2/28$_7$IV	-	-	15	-	2400	130	45	78	-	-	-	-	-	-
252	SCB 2/28$_{10}$IV	6	45	14	16	230	130	45	130	-	-	-	-	-	-
253	SCB 3/28$_2$IV	4	-	17	12.5	170	170	18	130	-	-	-	-	-	-
254	SCB 2/4$_3$IV	0	48	-2	3	24000	810	190	320	-	-	-	-	-	-
255	SCB 2/28$_2$IV	0	60	11	8	110	20	20	20	-	-	-	-	-	-
256	SCB 2/28$_5$IV	0	55	20	11	230	0	0	0	-	-	-	-	-	-
257	SCB 4/15$_2$IV	0	5	25	18	1100	1100	0	45	-	-	-	-	-	-
258	SCB 5/13$_3$IV	0	-	26	19	2200	2200	110	110	-	-	-	-	-	-
259	SCB 6/30$_1$IV	0	55	30	19	640	260	330	170	-	-	-	-	-	-
260	SCB 7/24$_2$IV	0	-	27	25	2200	1700	490	170	-	-	-	-	-	-
261	SCB 8/20$_3$IV	0	100	22	22	16000	5400	230	400	18	18	-	-	-	5.4
262	SCB 9/12$_3$IV	1	10	29	21	3500	1300	78	110	1300	130	700	490	0	-
263	SCB 9/25$_3$IV	0	-	27	16	330	330	230	230	0	0	460	210	0	7.8
264	SCB 10/12$_2$IV	0	-	25	16	700	700	140	460	0	0	170	130	0	-
265	SCB 10/31$_2$IV	1	90	21	17	790	790	170	790	0	0	790	790	0	-
266	SCB 11/15$_2$IV	0	27	14	11	2400	1300	68	140	0	0	330	110	0	-
267	SCB 2/4$_2$IV	0	79	-2	3	24000	810	260	320	-	-	-	-	-	-
268	SCB 2/28$_1$IV	0	35	11	9	20	20	20	20	-	-	-	-	-	-
269	SCB 2/28$_4$IV	0	30	23	9	45	0	0	0	-	-	-	-	-	-
270	SCB 4/15$_3$IV	0	2	23	19	9200	2800	0	110	-	-	-	-	-	-
271	SCB 8/20$_2$IV	0	115	23	22	24000	24000	230	81	68	68	-	-	-	4
272	SCB 9/12$_4$IV	1	9	31	21	3500	1700	140	170	2100	45	1800	170	0	-
273	SCB 9/25$_2$IV	0	-	28	16	330	330	45	110	0	0	330	170	0	7.2
274	SCB 10/12$_3$IV	0	-	24	16.5	490	330	230	170	0	0	120	61	2	-
275	SCB 10/31$_3$IV	0	30	22	16	230	230	78	130	0	0	330	330	0	-
276	SCB 11/15$_1$IV	1	18	16	11	3500	790	110	170	0	0	130	130	0	-
277	SCB 2/4$_1$IV	0	92	-2	1.5	810	810	210	320	-	-	-	-	-	-
278	SCB 4/15$_4$IV	0	10	22	14	9200	5400	0	280	-	-	-	-	-	-
279	SCB 8/20$_1$IV	0	80	23	22	24000	16000	230	68	68	68	-	-	-	5.0
280	SCB 9/25$_1$IV	2	-	26.5	18	330	230	20	78	0	0	230	0	0	7.5

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	ENB	Asp	Act	AZD	EVA	Vib	D.O
J 281	SCB 3/28$_{3}$III	19	-	17	12	18	18	0	0	-	-	-	-	-	-
282	SCB 3/28$_{6}$III	23	-	19	11.8	78	78	20	78	-	-	-	-	-	-
283	SCB 4/29$_{3}$III	21	10	26	22	170	18	18	0	-	-	-	-	-	-
284	SCB 9/12$_{4}$III	13	8	28	26	280	78	0	20	0	0	78	0	+/	-
285	SCB 12/7$_{3}$III	27	10	12	8.5	0	0	0	0	0	0	0	0	0	15
286	SCB 4/29$_{4}$III	25	5	26	22	170	18	18	0	-	-	-	-	-	-
287	SCB 6/30$_{4}$III	17	25	29	26.5	45	20	0	0	-	-	-	-	-	-
288	SCB 9/12$_{5}$III	15	12	27.5	26	0	0	0	0	0	0	78	0	+/	-
289	SCB 3/28$_{4}$III	21.5	-	18	12	0	0	0	0	-	-	-	-	-	-
290	SCB 3/28$_{5}$III	24	-	18	12.5	310	310	0	170	-	-	-	-	-	-
291	SCB 6/30$_{5}$III	20	20	24	26	130	20	0	0	-	-	-	-	-	-
292	SCB 9/12$_{6}$III	17	7	27	26	78	0	0	0	0	0	45	0	+/+	-
293	SCB 12/7$_{2}$III	28	10	12	8.5	1400	950	0	700	0	0	0	0	0	7.7
M 294	SCB 2/28$_{1}$III	18	15	15	-	0	0	0	0	-	-	-	-	-	-
295	SCB 2/28 III	25	10	15	-	20	20	20	20	-	-	-	-	-	-
296	SCB 3/28$_{1}$III	21	-	13	12.5	78	78	0	78	-	-	-	-	-	-
297	SCB 4/29$_{5}$III	28	5	17	22	130	0	0	0	-	-	-	-	-	-
298	SCB 9/12$_{7}$III	16	7	27	26	37	37	0	18	20	0	310	18	+/	-
299	SCB 11/7$_{1}$III	30	8	14	9	0	0	0	0	0	0	0	0	/	7.5
L 300	SCB 1/17$_{1}$III	2	-	2	2	270	40	0	18	-	-	-	-	-	-
301	SCB 1/21$_{1}$III	0	55	10	10	3500	1100	120	61	-	-	-	-	-	-
302	SCB 2/28$_{7}$III	0	20	22	10	-	-	-	-	-	-	-	-	-	-
303	SCB 4/29$_{6}$III	0	10	25	20	790	330	0	20	-	-	-	-	-	-
304	SCB 5/27$_{1}$III	1	70	23	20	1700	490	110	140	-	-	-	-	-	-
305	SCB 7/24$_{2}$III	0	50	30	27	1500	950	330	210	-	-	-	-	-	-
306	SCB 10/12$_{1}$III	1	-	25	15	330	230	45	45	40	0	82	18	-	-
307	SCB 11/15$_{1}$III	0	42	17	10	61	18	0	0	0	0	130	20	-	-
308	SCB 1/17$_{7}$ V	5	-	2	2	490	490	490	490	-	-	-	-	-	-
309	SCB 1/21$_{1}$ V	2	50	9	9	2200	790	790	790	-	-	-	-	-	-
310	SCB 4/29$_{1}$ V	14	5	27	25	790	330	330	170	-	-	-	-	-	-

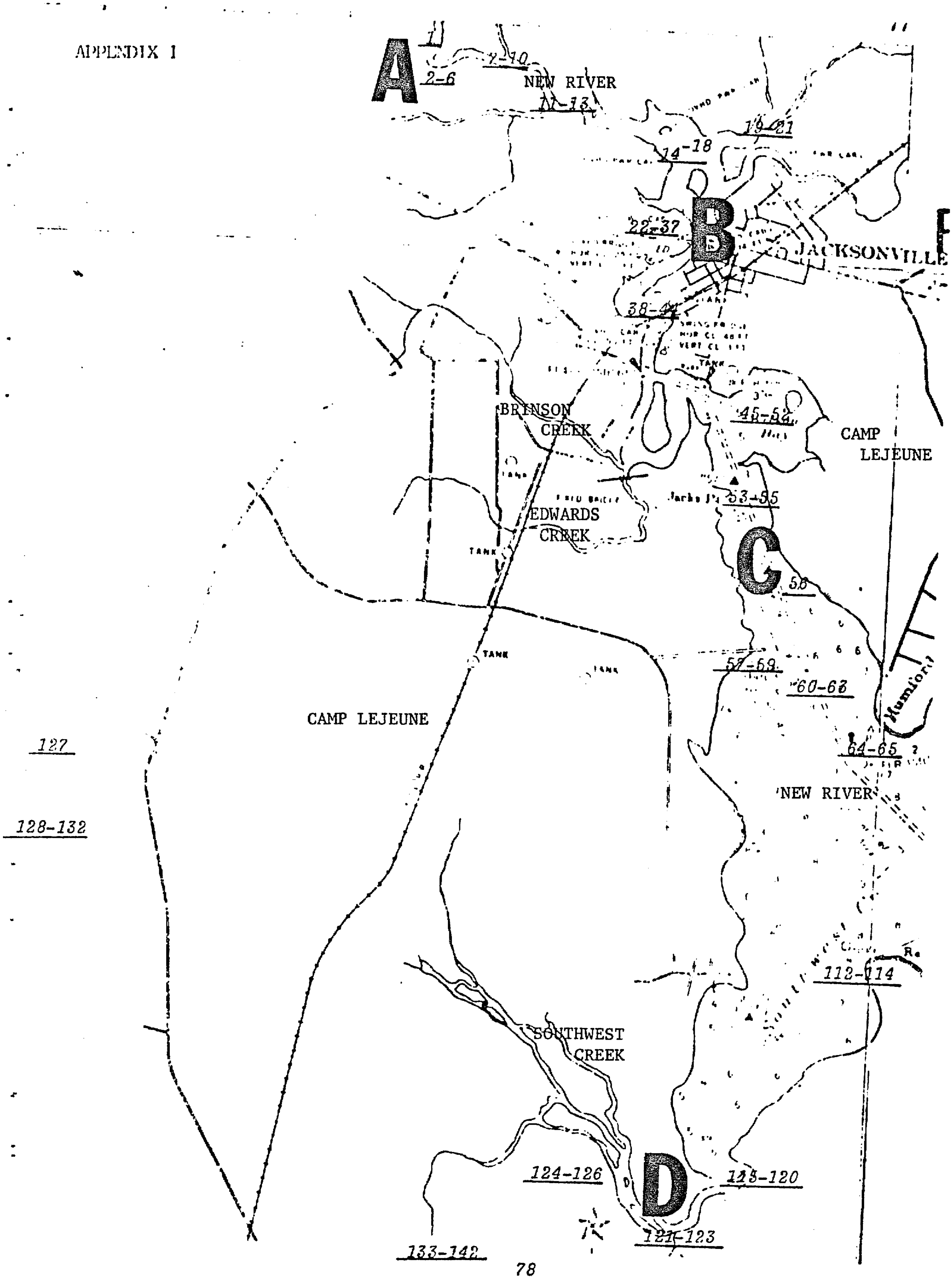
APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
311	SCB 5/27$_4$V	2	90	23	23	790	790	330	220	-	-	-	-	-	-
312	SCB 6/30$_3$V	13	40	26	26	24000	9200	110	110	-	-	-	-	-	-
313	SCB 7/24$_1$V	11	45	29	28	9200	5400	130	0	490					
314	SCB 8/20$_1$V	0	145	23	21	24000	24000	230	240	20	20	-	-	-	-
315	SCB 10/12$_3$V	15	-	27	18	9200	9200	460	9200	18	0	440	170	-	-
316	SCB 11/15$_1$V	22	29	17	12	24000	5400	490	2200	330	45	490	330	-	-
317	SCB 1/17$_{11}$V	0	-	2	2	330	130	0	20	-	-	-	-	-	-
318	SCB 1/21$_2$V	1	65	9	8	1100	460	45	110	-	-	-	-	-	-
319	SCB 5/27$_5$V	1	80	23	19	330	330	20	20	-	-	-	-	-	-
320	SCB 7/24$_2$V	1	95	28	29	1700	1700	0	82	-	-	-	-	-	-
321	SCB 10/12$_4$V	0	-	25	16	3500	2400	78	270	230	130	20	0	-	-
322	SCB 11/15$_2$V	0	73	18	12	1800	460	0	210	0	0	490	0	-	-
323	SCB 1/17$_9$V	0	-	2	2	110	20	0	0	-	-	-	-	-	-
324	SCB 1/21$_4$V	0	65	9	9	130	130	45	20	-	-	-	-	-	-
325	SCB 7/24$_3$V	0	90	30	29	2200	470	20	20	-	-	-	-	-	-
326	SCB 1/17$_8$V	0	-	2	2	270	220	45	93	-	-	-	-	-	-
327	SCB 1/21$_5$V	0	45	9	9	230	230	130	45	-	-	-	-	-	-
328	SCB 5/27$_3$V	1	70	24.5	20	700	330	110	170	-	-	-	-	-	-
329	SCB 7/24$_4$V	0	55	30	29	5400	3500	20	130	-	-	-	-	-	-
M 330	SCB 1/17$_{10}$V	14	-	2	2	1100	180	0	180	-	-	-	-	-	-
331	SCB 1/21$_8$V	9	30	9	9	3500	790	130	220	-	-	-	-	-	-
332	SCB 5/27$_6$V	21	40	24	23	490	490	40	330	-	-	-	-	-	-
333	SCB 3/28$_2$V	24.5	-	16	12	310	310	0	170	-	-	-	-	-	-
334	SCB 6/30$_2$V	21	20	26	26	78	20	0	0	-	-	-	-	-	-
335	SCB 9/12$_2$V	16	8	29	26	20	20	0	0	0	0	20	0	+/	-
336	SCB 1/17$_2$V	21	-	2	2	790	270	0	110	-	-	-	-	-	-
337	SCB 1/17$_3$V	19	-	2	2	45	45	20	20	-	-	-	-	-	-
338	SCB 5/27$_2$V	28	90	24	24	45	20	0	20	-	-	-	-	-	-
339	SCB 6/30$_1$V	14	30	28	26	130	0	0	0	-	-	-	-	-	-
340	SCB 9/12$_1$V	16	5	28.5	26	55	55	0	0	0	0	20	0	0	-

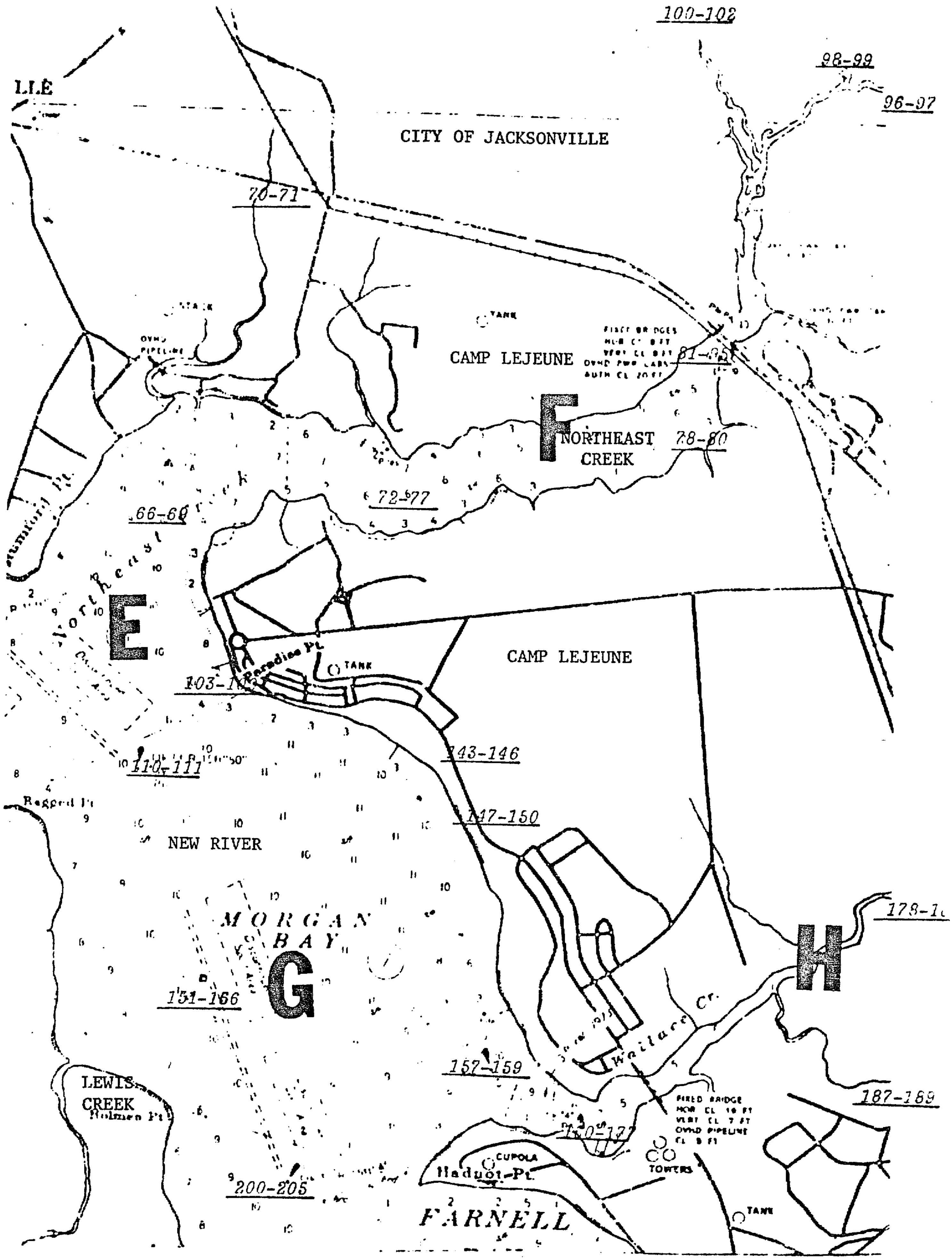
APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
341	SCB 1/17$_1$V	0	-	-2	0	490	330	220	330	-	-	-	-	-	-
342	SCB 2/28$_2$V	0	40	21	13	330	330	330	45	-	-	-	-	-	-
343	SCB 5/27$_1$V	8	80	24	25	3500	1700	330	130	-	-	-	-	-	-
344	SCB 7/24$_6$V	5	70	30	28	2400	1300	1300	0	230	-	-	-	-	-
345	SCB 10/12$_2$V	19	-	27	19.5	3500	3500	1300	3500	0	-	5400	3300	-	-
346	SCB 10/31$_2$V	10	175	18	17.5	700	700	230	700	20	20	1300	230	91/1	-
347	SCB 1/17$_4$V	-	-	2.5	.8	400	210	120	82	-	-	-	-	-	-
348	SCB 1/21$_6$V	0	55	12	7	3500	1700	700	1400	-	-	-	-	-	-
349	SCB 4/29$_2$V	2	1	27	20.5	1300	1300	45	45	-	-	-	-	-	-
350	SCB 5/27$_8$V	1	70	24.5	20	700	330	110	170	-	-	-	-	-	-
351	SCB 6/30$_4$V	0	120	26	19	16000	540	140	240	-	-	-	-	-	-
352	SCB 7/24$_5$V	0	105	30	27	1800	1800	0	61	-	-	-	-	-	-
353	SCB 10/12$_1$V	1	-	27	15	9200	1700	490	1700	110	0	490	140	5/	-
354	SCB 10/31$_1$V	0	55	19	14	2800	2800	2800	2800	0	0	16000	16000	0	-
355	SCB 11/15$_3$V	5	57	17	11	24000	2800	490	3500	120	20	3500	3500	0	-
356	SCB 1/17$_1$VII	23	18	-2.8	.2	0	0	0	0	-	-	-	-	-	-
357	SCB 3/28$_1$VII	23.5	-	18	12.5	0	0	0	0	-	-	-	-	-	-
358	SCB 4/29$_1$VII	29	1	27	22	230	0	0	0	-	-	-	-	-	-
359	SCB 6/30$_1$VII	20	30	28	-	330	20	0	0	-	-	-	-	-	-
360	SCB 8/20$_1$VII	16	190	24	22	24000	24000	310	55	24000	3500	-	-	-	6.6
361	SCB 9/25$_1$VII	22	-	27	21	20	0	0	0	0	0	230	0	.57/1	-
362	SCB 10/12$_1$VII	24	-	25	17.5	490	330	0	68	0	0	91	45	157/5	7.5
363	SCB 10/31$_1$VII	38	40	22	17	130	0	0	0	0	0	230	20	106/2	-
364	SCB 11/15$_1$VII	30	13	15	10	790	330	45	110	0	0	20	0	47/	-
365	SCB 12/7$_1$VII	31	10	14	8.5	0	0	0	0	0	0	0	0	0	7.0
366	SCB 9/12$_1$VII	20	2	27.5	25.5	20	0	0	0	0	0	230	0	4/	-

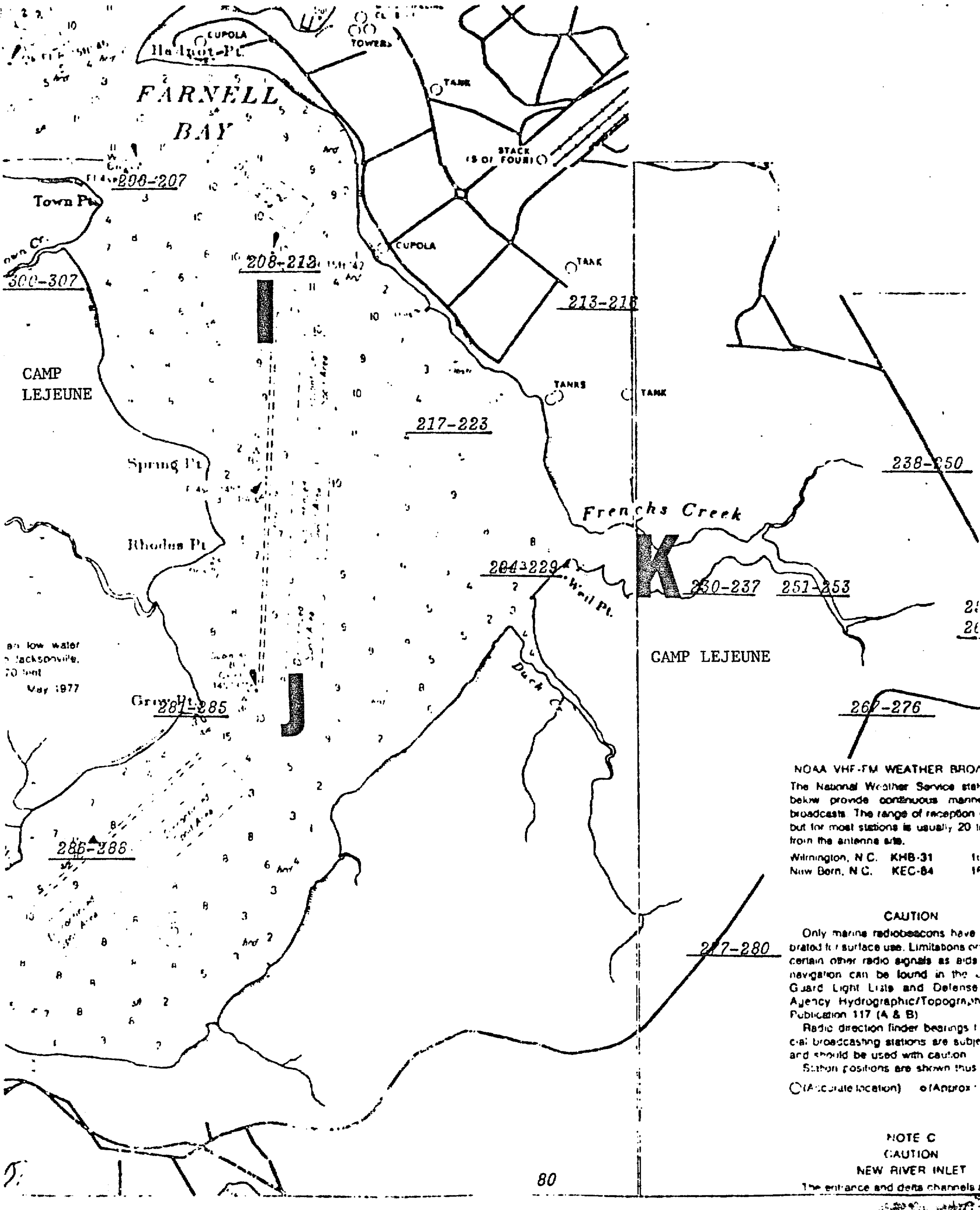
APPENDIX I

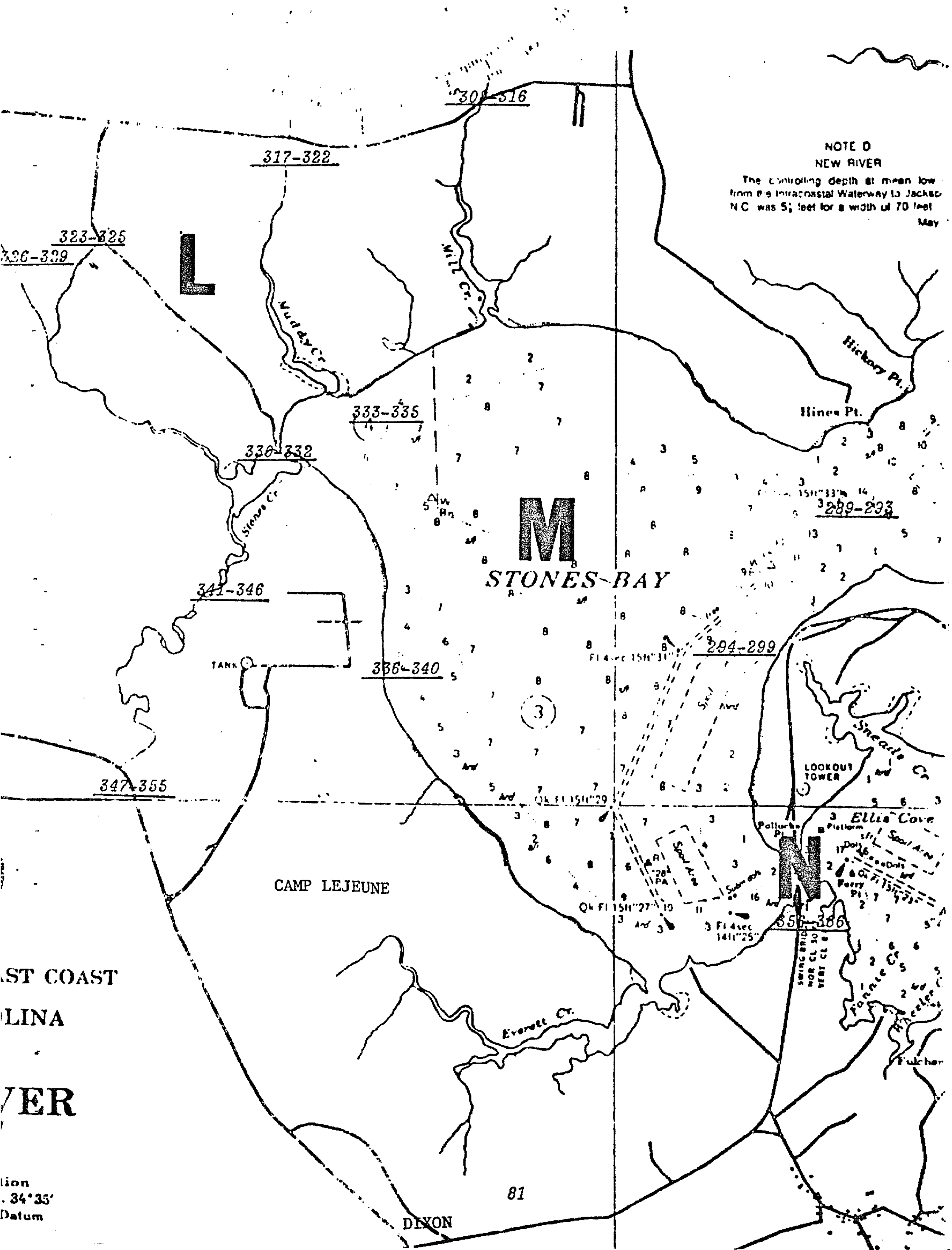


A
B
C
D
1
2-6
7-10
NEW RIVER
11-13
14-18
19-21
22-37
JACKSONVILLE
38-44
BRINSON CREEK
45-52
CAMP LEJEUNE
EDWARDS CREEK
53-55
56
57-59
60-63
64-65
CAMP LEJEUNE
NEW RIVER
Humiford
112-114
SOUTHWEST CREEK
124-126
115-120
121-123
133-142
127
128-132
TANK



100-102
98-99
96-97
LLE
CITY OF JACKSONVILLE
70-71
CAMP LEJEUNE
81-85
F
NORTHEAST
CREEK
78-80
72-77
66-69
Northeast Creek
E
Paradise Pt.
TANK
103-10
CAMP LEJEUNE
143-146
110-111
Ragged Pt
NEW RIVER
147-150
MORGAN
BAY
G
151-166
H
178-1
Wallace Cr.
157-159
LEWIS
CREEK
Holmen Pt.
187-189
170-177
CUPOLA
TOWERS
Hadnot Pt.
200-205
FARNELL
TANK


CUPOLA
TOWERS
Hadnot Pt.
FARNELL
BAY
TANK
STACK
(S OF FOUR)
208-207
Town Pt.
300-307
208-212
I
CUPOLA
TANK
213-216
CAMP
LEJEUNE
TANKS
TANK
217-223
Spring Pt.
238-250
Frenchs Creek
Rhodes Pt.
K
204-229
Weil Pt.
230-237
251-253
Duck Cr.
CAMP LEJEUNE
J
281-285
267-276
286-288
277-280
NOAA VHF-FM WEATHER BROA
The National Weather Service stat
below provide continuous marine
broadcasts. The range of reception
but for most stations is usually 20 t
from the antenna site.
Wilmington, N.C. KHB-31
New Bern, N.C. KEC-84
CAUTION
Only marine radiobeacons have
brated for surface use. Limitations on
certain other radio signals as aids
navigation can be found in the
Guard Light Lists and Defense
Agency Hydrographic/Topograph
Publication 117 (A & B)
Radio direction finder bearings t
cial broadcasting stations are subje
and should be used with caution
Station positions are shown thus
(Accurate location)
(Approx
NOTE C
CAUTION
NEW RIVER INLET
The entrance and delta channels


NOTE D
NEW RIVER
The controlling depth at mean low from the Intracoastal Waterway to Jackso N.C. was 5½ feet for a width of 70 feet May
L
M
N
STONES BAY
CAMP LEJEUNE
Muddy Cr.
Mill Cr.
Stones Cr.
Everett Cr.
Hickory Pt.
Hines Pt.
Sneads Cr.
Ellis Cove
LOOKOUT TOWER
TANK
DIXON
Spoil Area
306-316
317-322
323-325
326-329
330-332
333-335
336-340
341-346
347-355
289-293
294-299
356-366
ST COAST
LINA
VER
tion
. 34°35'
Datum

APPENDIX II

Suppliers

Sigma Chemical Co.	- DL-asparagine (pfs) acetamide (pfs) phenol red acid free
Fisher Scientific Co.	- phosphate buffer (pH 7.2) potassium phosphate dibasic potassium phosphate monobasic polyethylene gloves borosilicate glass culture tubes, 18 X 150 borosilicate glass bottles, 250 ml Azide Dextrose Broth Ethyl Violet Azide Broth TCBS agar microscope slide labels 6" cotton-tipped applicators
American Scientific Co.	-Bacto-agar Lauryl Tryptose broth thermometers EC media Brilliant Green Bile Broth 2% Eosin Methylene Blue agar American Optical refractometer
International Products	- "MICRO" glassware soap
Hach Chemical Co.	- Direct Reading Engineers Laboartory DR-EL/4
YSI Scientific	- field oxygen meter model 57

APPENDIX III - SALINITY, TURBIDITY AND WATER TEMPERATURE GRAPHS AT SIX STATIONS OF THE NEW RIVER ESTUARY

FIGURE 13 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 1 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

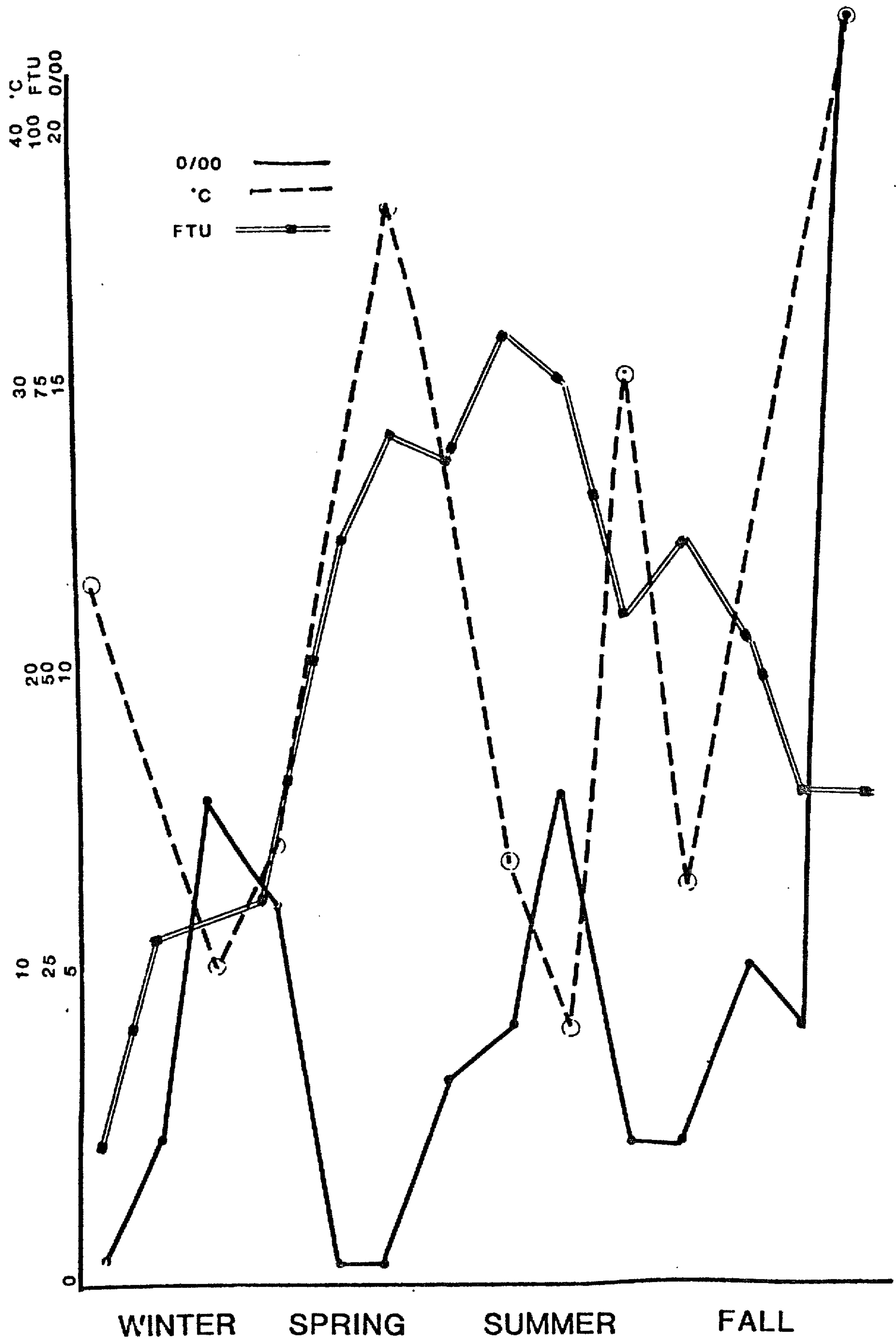
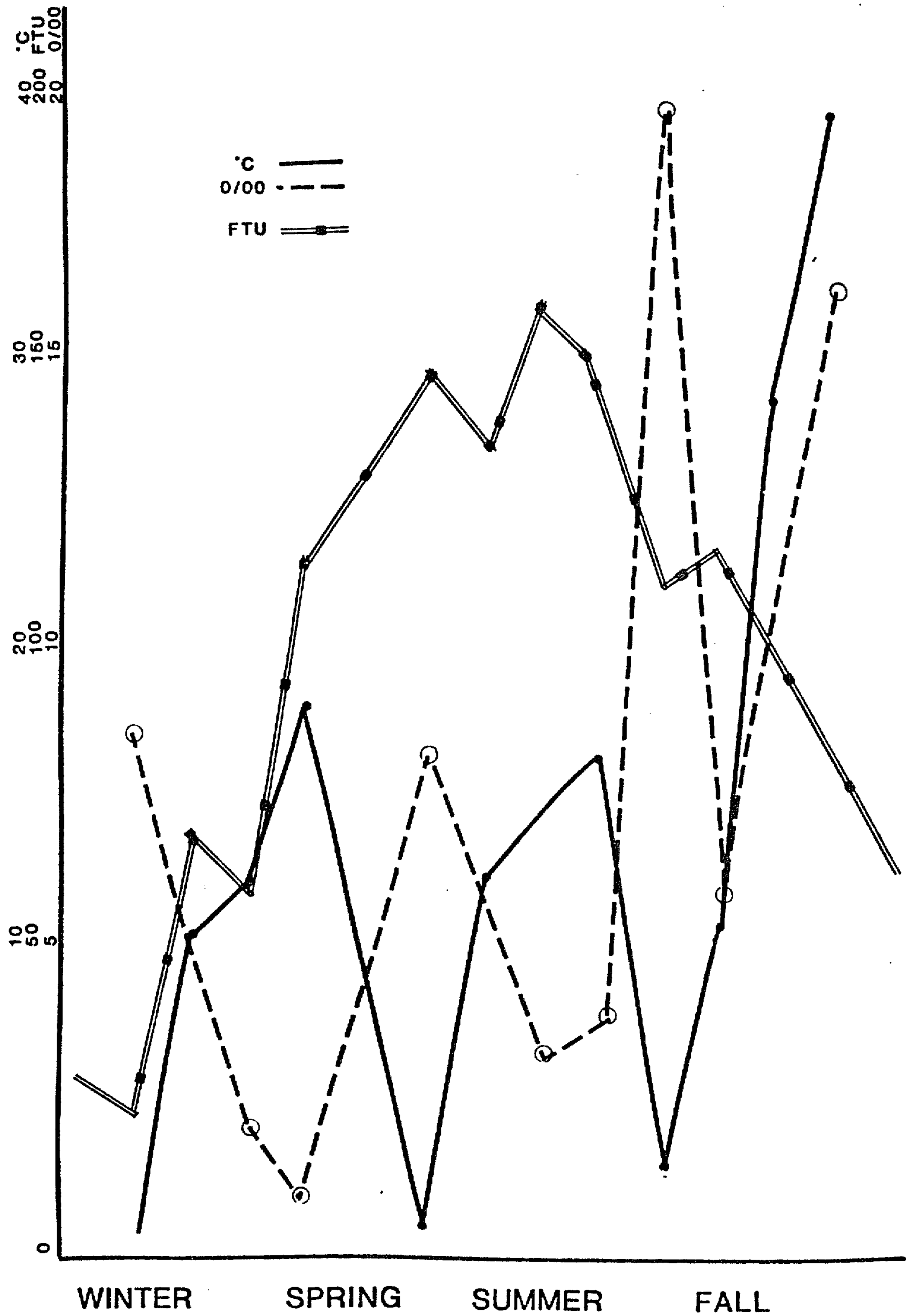

40
100
20
°C
FTU
0/00
30
75
15
20
50
10
10
25
5
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 14 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 2 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY



°C
FTU
0/00
40
200
20
30
150
15
20
100
10
10
50
5
0
°C
0/00
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 15 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 3 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

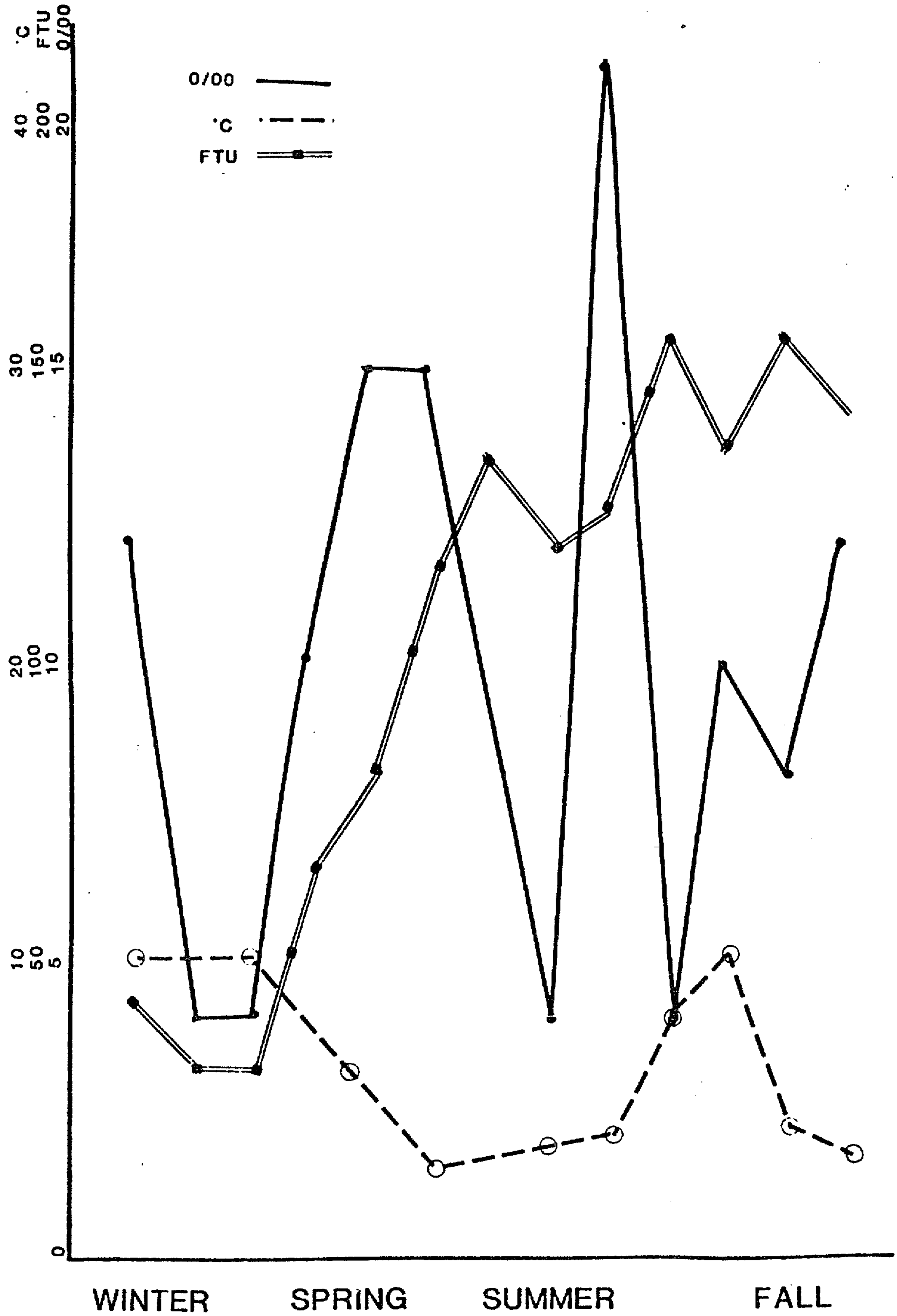
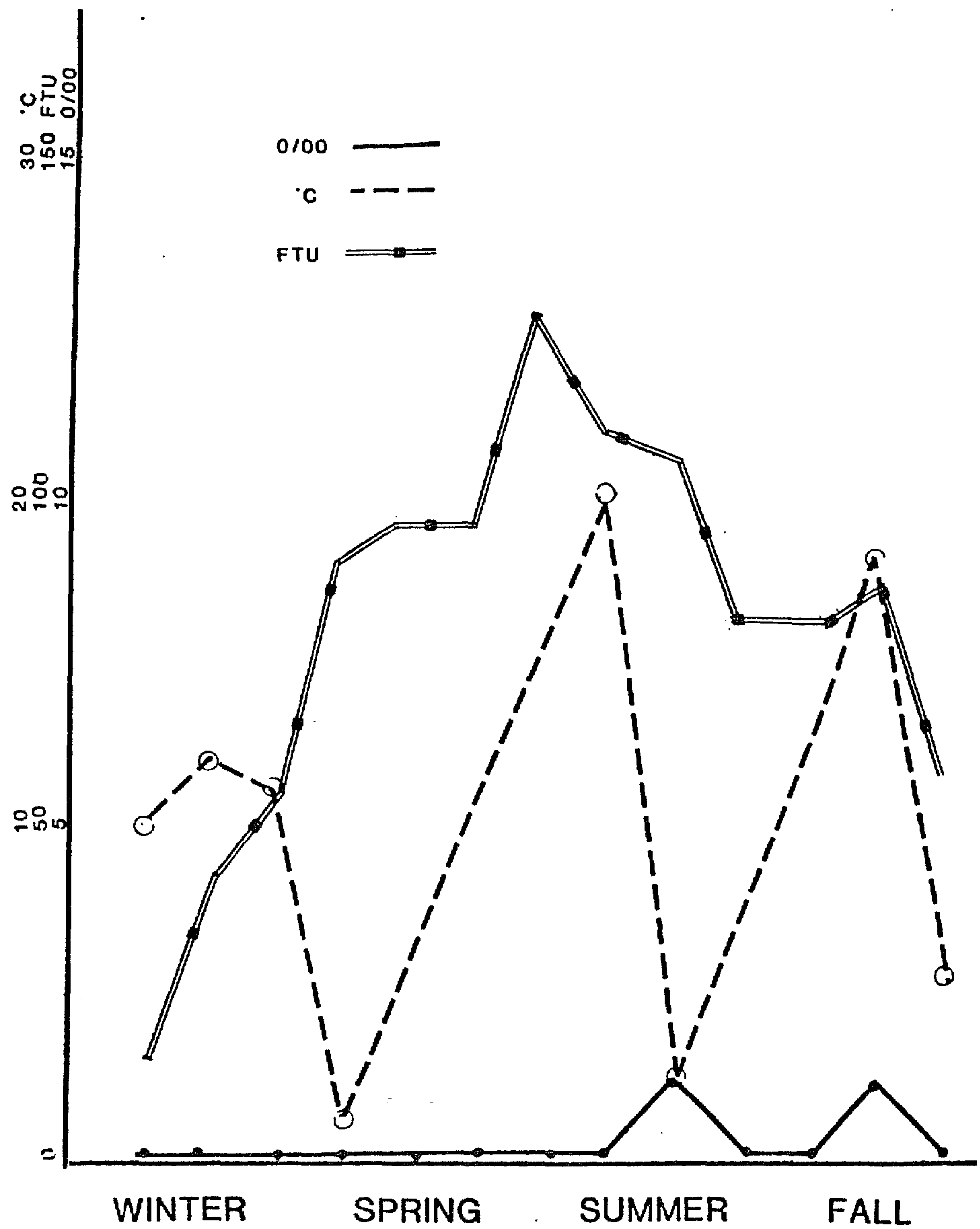
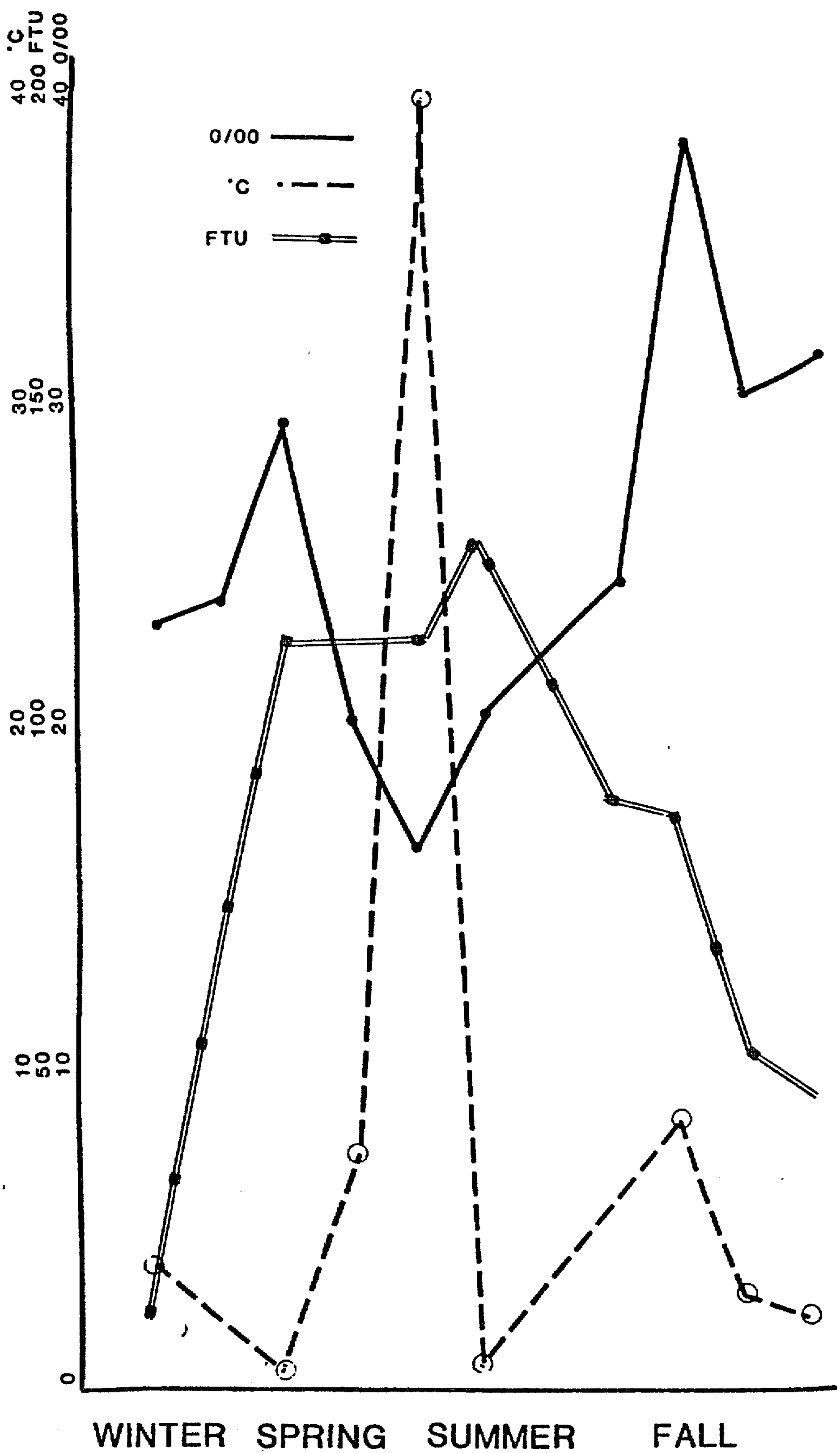

°C
FTU
0/00
40
200
20
30
150
15
20
100
10
10
50
5
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 16 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 4 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY



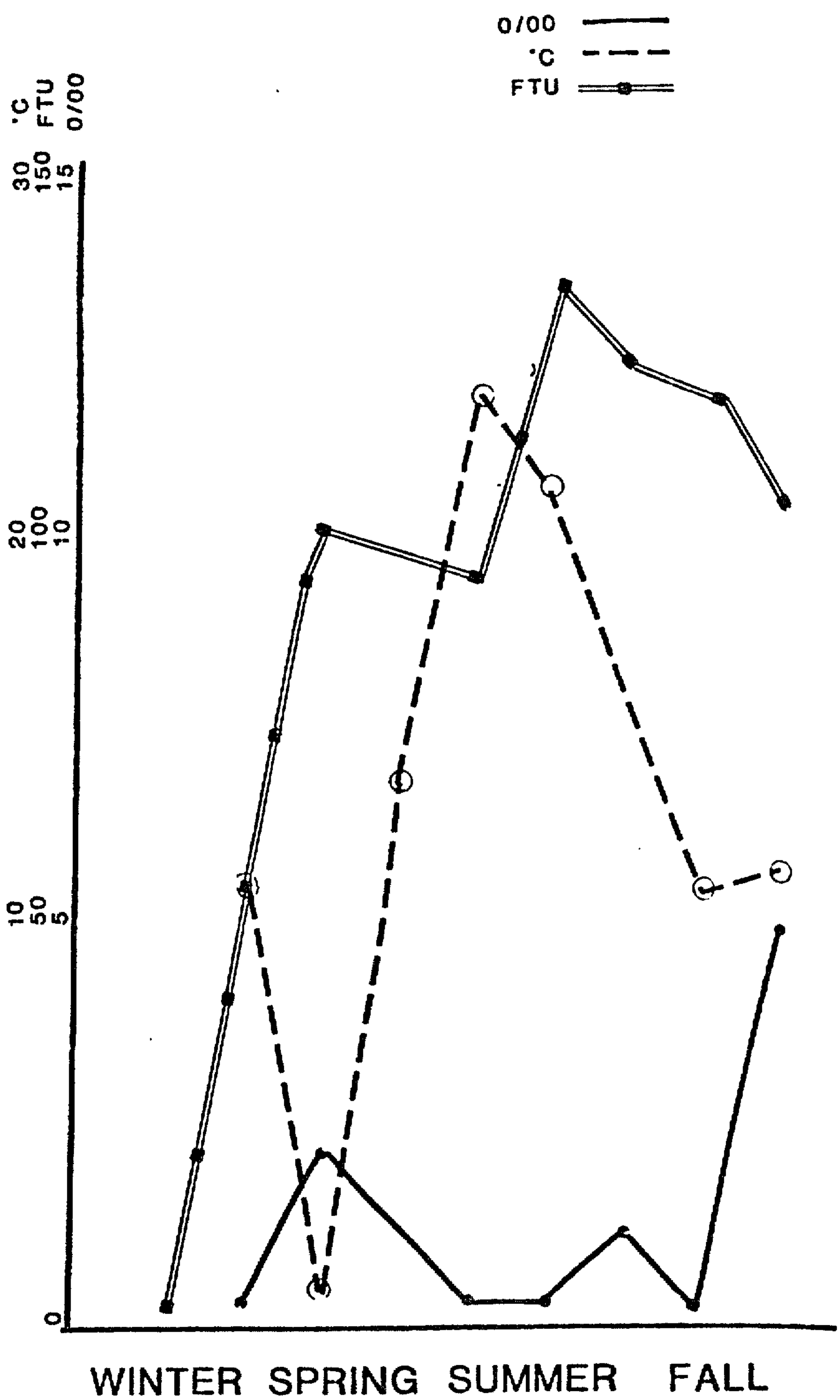
30 °C
150 FTU
15 0/00
20
100
10
10
50
5
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 17 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 6 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY



40 °C
200 FTU
40 0/00
30
150
30
20
100
20
10
50
10
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 18 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 7 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY



0/00
°C
FTU
30 150 15
°C FTU 0/00
20 100 10
10 50 5
0
WINTER SPRING SUMMER FALL

University of North Carolina

at Wilmington

28406

APPENDIX 4 - NEW RIVER STUDY QUESTIONNAIRE

A study of the New River estuary has been conducted by the University of North Carolina at Wilmington over the past two years. One of the project goals is to increase fishing and other recreational usage of the estuary. However, we need to ascertain the present level of such usage, information that can be supplied by such users as yourself. We would greatly appreciate your taking a few minutes to complete the enclosed questionnaire. Because responses will be computerized, individual replies will not be identified. Personal comments are welcome in addition to the survey questions.

For your convenience, a stamped return envelope is enclosed. Thank you for your participation.

Sincerely,

G. Bane

Gilbert W. Bane, Ph.D.
Director, Environmental Studies
Principal Investigator

13. Approximately how many pounds did your total catch weigh during the past 12 months?

( ) 0-100
( ) 100-500
( ) 500-1000
( ) 1000-5000
( ) 500-10,000
( ) 10,000-20,000
( ) 20,000-50,000
( ) more than 50,000

14. Is your fishing activity for a particular species? ( )yes ( )no

15. What type of fishing gear and method do you usually use? (Check all that apply)

gear
( )pole and line
( )gill net
( ) seine
( ) cast net (bait)
( ) rake, tong
( ) gig
( ) dredge
( ) other__________

method
( ) trawling
( ) still fishing
( ) drifting
( ) casting
( )other__________

16. If you knew in advance that you wouldn't have caught anything in the bay area today, how much money would you have spent on some other activity in Onslow County?

( ) $0-10
( ) $10-$50
( ) $50-$100
( )$100-$300
( )$300-$500
( ) more than $500

17. What is your occupation? (   )

18. Would you indicate which catagory most closely corresponds to your income for the past 12 months?

( )less than $5000
( )$5000-$10,000
( )$10,000-$15,000
( )$15,000-$20,000
( )$20,000-$30,000
( )$30,000-$40,000
( )$40,000-$50,000
( ) more than $50,000

19. Comments on improving the use of the New River

ALL ANSWERS WILL BE KEPT CONFIDENTIAL

1. What is the nature of your activity in the New River area? (check all that apply)
   ( ) swimming
   ( ) recreational boating
   ( ) recreational fishing and/or shellfishing
   ( ) commercial fishing and/or shellfishing

2. Approximately how often do you use the New River for your activity?
   ( )/month
   ( )/year

3. Which general area do you usually use for your activity? (Refer to charts and/or maps)
   ( )A ( )B ( )C ( )D ( )E ( ) F ( )G ( )H ( )I ( )J ( )K ( )L ( )M ( )N

4. How many years have you fished in this area? ( )years

5. For how many years in the future do you expect to fish in the New River area?
   ( )years

6. If you used a boat on your last trip: Type of boat( )
   Length of boat ( )ft.
   Number in party ( )males ( )females
   How many days spent in area on trip? ( )days
   Is this your own boat? ( )yes ( )no
   Did (will) you stay overnight in this county as a result of this trip?
   ( )yes ( )no
   At a private residence ( )yes ( )no
   Public lodging ( )yes ( )no

7. Approximately what were the total expenses incurred on this trip in Onslow County?
   ( )0-$50 ( )$50-$100 ( ) $100-$500 ( ) $500-$1000 ( ) over $1000

8. Where do you usually launch your boat? ( )private ( )public

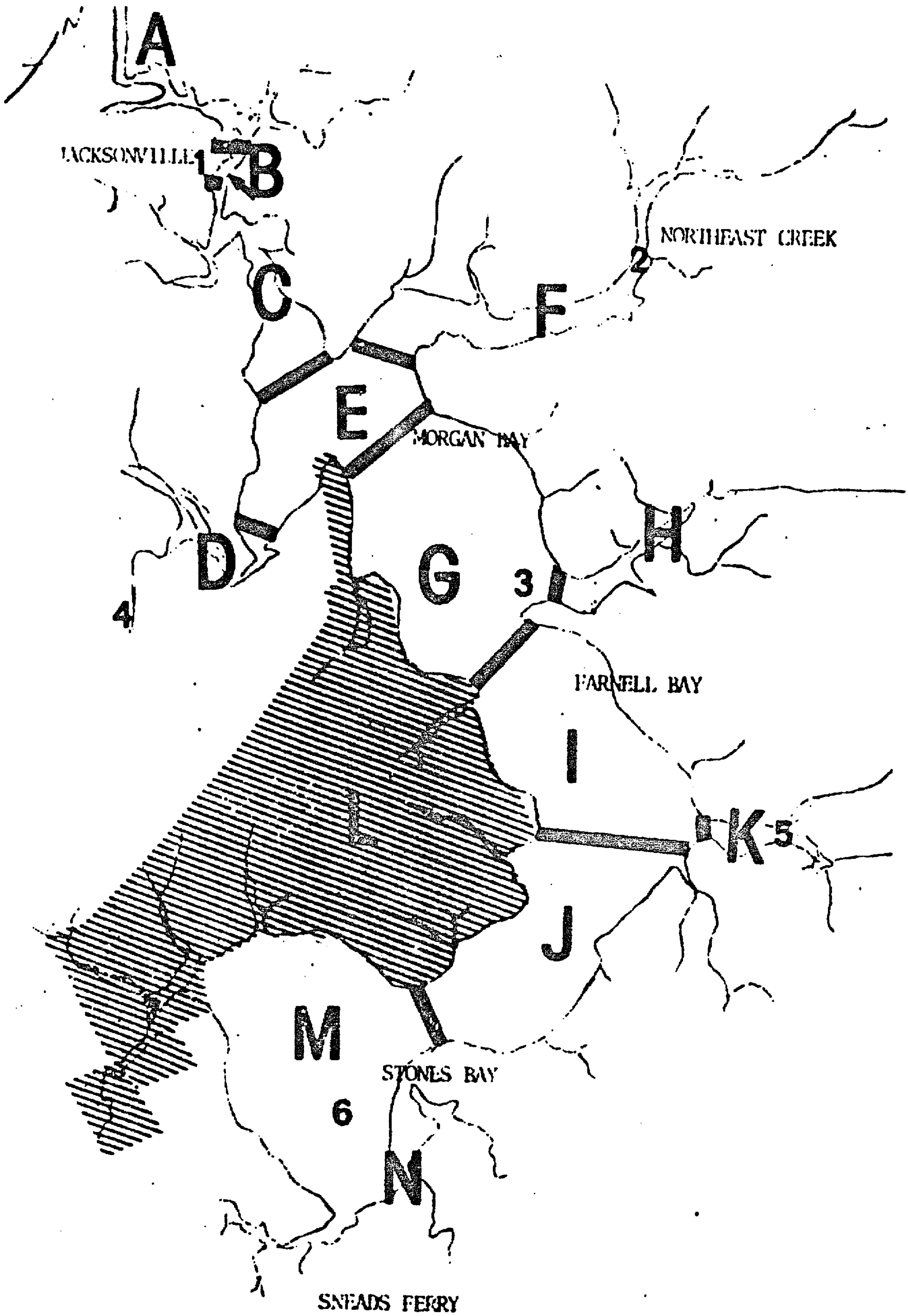
9. What is the approximate value of your boat and gear?
   ( ) less than $500
   ( ) $500-$1000
   ( ) $1000-$5000
   ( ) $5000-$20,000
   ( ) $20,000-$50,000
   ( ) $50,000-$100,000
   ( ) $100,000-$500,000
   ( ) more than $500,000

10. How much have you spent in the last 12 months on boat expenses and gear?
   ( )less than $100
   ( ) $100-$500
   ( ) $500-$1000
   ( ) $1000-$5000
   ( ) $5000-$20,000
   ( ) $20,000-$50,000
   ( ) more than $50,000

11. If fishing...what percent:

sport or recreational	commercial
( ) 0-5	( ) 0-5
( ) 5-10	( ) 5-10
( ) 10-25	( ) 10-25
( ) 25-50	( ) 25-50
( ) 50-75	( ) 50-75
( ) 75-100	( ) 75-100

12. Is your catch sold? ( )yes ( )no


A
JACKSONVILLE
1
B
NORTHEAST CREEK
2
C
F
E
MORGAN BAY
D
G
3
H
4
FARNELL BAY
I
L
K
5
J
M
STONES BAY
6
N
SNEADS FERRY