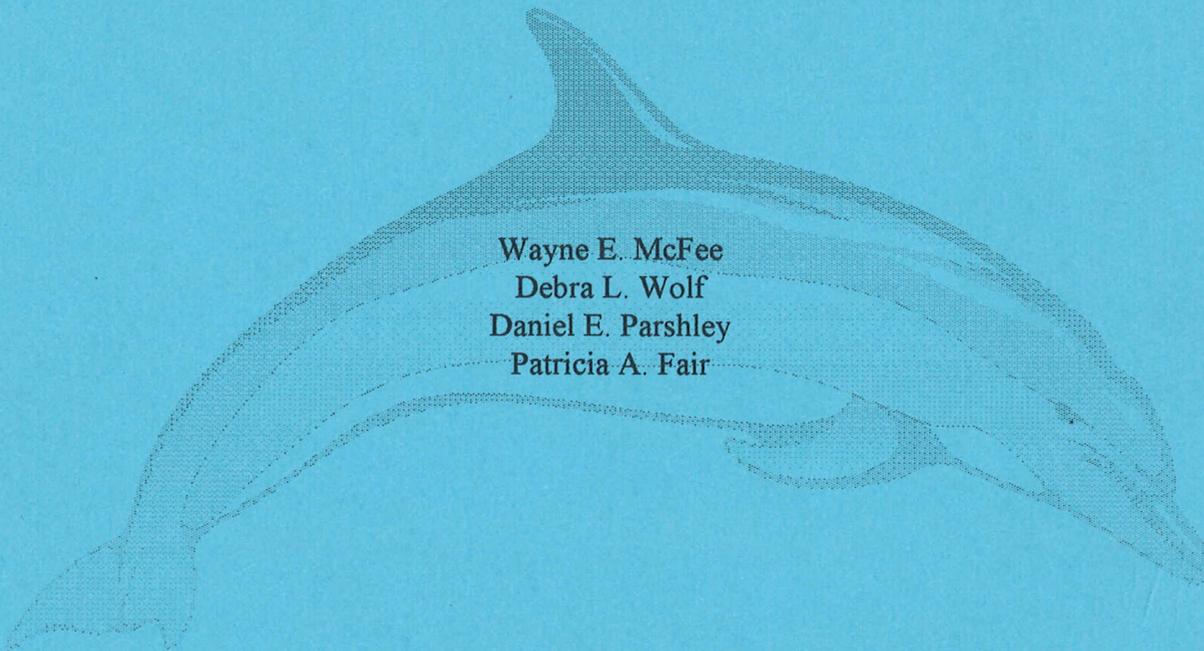




NOAA TECHNICAL MEMORANDUM NMFS-SEFSC-386

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INVESTIGATION OF MARINE MAMMAL  
ENTANGLEMENT ASSOCIATED WITH  
A SEASONAL COASTAL NET FISHERY



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June 1996

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National Marine Fisheries Service  
Southeastern Fisheries Science Center  
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Charleston, SC 29422-0607



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JUNE 1996

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## ABSTRACT

An ocean gillnet fishery for American shad (*Alosa sapidissima*) operates during the months of February to April in South Carolina waters. As with many other fisheries along the southeastern United States coast, this fishery has not been well characterized in terms of effort, landings, bycatch, and impact on marine mammals. This study was initiated when twelve (12) cetacean strandings, comprising five (5) species, occurred during the South Carolina shad fishing season in the area of shad fishery effort in 1993. The main objectives were to a) investigate the potential impact of the ocean shad fishery on marine mammal mortality and b) describe the ocean shad fishery. Aerial surveys were conducted during Year 1 (1994) of the study to document the spatial coverage of shad fishery effort and detect marine mammal strandings. Boat surveys were added to the aerial surveys for Year 2 (1995) to further characterize the shad fishery and document dolphin/net interactions. One stranding of a bottlenose dolphin (*Tursiops truncatus*) occurred during Year 1 in the area of effort, and it was determined not to be related to the fishery. Three bottlenose dolphins stranded in the area of effort during Year 2, but the causes of death could not be determined. Results from this study support the NMFS classification of this gillnet fishery as a Category III fishery: unlikely to take marine mammals during the course of its operations.

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## INTRODUCTION

The ocean shad fishery in South Carolina is one of many fisheries along the southeastern U.S. coast that has been poorly documented, both in methodology and potential risk for marine mammal entanglement. The Marine Mammal Protection Act of 1972 was amended in 1988 to require the classification of fisheries based on their potential impact on marine mammal mortality. The National Marine Fisheries Service (NMFS) has classified the shad gillnet fishery a Category III fishery, as unlikely to take marine mammals (Read, 1994).

During the months of February to April there is an ocean gillnet fishery for American shad (*Alosa sapidissima*) along the coast of South Carolina. American shad are anadromous fish spending most of their adult life at sea, and returning to the rivers to spawn in spring (Richkus and Dinardo, 1984; Facey and Van Den Avyle, 1986). During 1994, the shad fishery season was February 1 to April 2; during 1995, the shad fishery season was February 1 to April 15 as determined by the South Carolina Department of Natural Resources (SCDNR). The gillnets, approximately 1800 m in length and reaching up to 6 m in depth, are set perpendicular to the shoreline just outside the breakers. Since 1985 there has been a requirement that nets be continuously attended.

In past years, there has been little effort to document marine mammal strandings in the remote coastal areas near the primary shad fishery locations. During the spring of 1993, aerial surveys for leatherback sea turtles (*Dermochelys coriacea*) along the South Carolina coast provided an opportunity to scan the coast for marine mammal strandings. Some of the strandings noted during these flights occurred on the uninhabited beaches near an area of shad fishery effort.

Of note were two beaked whales (*Mesoplodon* spp.), a dwarf sperm whale (*Kogia simus*), two pygmy sperm whales (*Kogia breviceps*), and six bottlenose dolphins (*Tursiops truncatus*).

During 1992-1995, there have been 28 documented strandings in the area where the shad fishery operates. Eight of these occurred during the period when the fishery was operating: one in 1992, three in 1993, one in 1994, and three in 1995.

Bottlenose dolphins are of particular interest since the Atlantic coastal migratory stock was declared depleted by NMFS (58 FR 17789, 1993). Since 1993, increased attention has been focused on the problems of incidental mortality of marine mammals in gillnets and other fishing gear. Lack of information on the description of such fisheries has hindered evaluating the magnitude of these problems. This study attempted to evaluate the magnitude of dolphin mortality in the ocean shad fishery in South Carolina.

As a result of the above aerial surveys, an investigation of marine mammal entanglement associated with the ocean shad fishery was performed during the 1994 and 1995 shad fishery seasons. The objectives of this investigation were to a) determine the level of marine mammal mortality in the shad fishery, b) describe the coastal shad fishery in South Carolina using a boat observer and aerial surveys, and c) describe any associations between dolphins and the shad nets.

## METHODOLOGY

### Aerial Surveys

During Year 1 (1994) of the study, aerial surveys were performed in conjunction with the SCDNR. The majority of flights were made in a Cessna 182 high-wing State plane, with the exception of two flights which used a Cessna 206 high-wing State plane. Most flights departed from the Walterboro Airport, the remaining from Charleston Executive Airport on John's Island. Each flight consisted of an along-shore transect and an offshore transect. The along-shore transect was flown at 76 m altitude, and the offshore at 305 m altitude. Survey effort was maintained during transect between the along-shore and offshore transect. If departing from Walterboro, the flight path was directed southwest along the beaches to Port Royal Sound, just north of Hilton Head Island, then turned southeast heading to one mile offshore. The flight path was then directed northeast paralleling the coastline until opposite Murrel's Inlet, then headed inshore and descended for the path southwest along the beaches back to Walterboro (Figure 1). If departing from John's Island, the flight path was directed east following the Stono River to Seabrook Island and then following the flight path south as described above. Surveys were conducted once-a-week, weather permitting, from January 20, 1994 to April 14, 1994.

During Year 2 (1995) of the study, aerial surveys were conducted using a Cessna 182 high-winged plane. The flight path differed from Year 1 in that all surveys departed from John's Island and were extended southwest to the Savannah River on the South Carolina-Georgia border and northeast to the Little River Inlet on the South Carolina-North Carolina border (see Figure 1). Surveys were conducted once each week, weather permitting, from January 27, 1995 to April 18, 1995.

The surveys consisted of at least two observers and a pilot. One observer occupied the right front seat, the other occupied the left rear seat. During the beach along-shore transects, the right side observer monitored the beaches for any marine mammal strandings. Marine mammal strandings were circled to obtain latitude/longitude positions via the plane's GPS. The left side observer monitored the nearshore water for live, free-swimming marine mammals and shad nets and boats. Numbers of marine mammals encountered, their direction of travel, and behavior were recorded, but not circled unless in proximity to a shad net. Also, latitude/longitude positions were recorded using the plane's GPS system for each marine mammal sighting and each shad net and boat observed. Shad nets were circled to document position and any associations between marine mammals and nets. These associations included distance from nets, behavior near nets (e.g. - feeding, diving, etc.), direction of travel, and entanglement.

During the offshore transects, both observers monitored the offshore water for shrimp boats and live, free-swimming marine mammals. Numbers of shrimp boats and marine mammals encountered and their direction of travel were recorded, but not circled. Shad nets and boats that could be seen along the beach were not recorded so as to not duplicate records on the beach transects. Sightings were obtained via the plane's GPS system. All data was recorded on Shad Fishery/Dolphin Entanglement data sheets (Appendix A), with time of sighting, location, latitude, longitude, number of nets and boats, and number of dolphins later recorded in a database.

Marine mammal strandings were responded to by either the NMFS or SCDNR personnel upon landing. When possible, the stranded animal was transported to the NMFS Charleston Laboratory for necropsy; otherwise the animal was necropsied on site. The animals were

examined for indications of human interactions, such as bruising, rope marks, mutilation, etc.; interaction signs were photographically documented. Tissues collected for histopathology were sent to the Armed Forces Institute of Pathology (AFIP) in Washington, D.C. for examination to determine possible cause of death. All skeletal materials were processed using dermestid beetles, and then were examined to document any fractures or lesions.

### Boat surveys

Boat surveys were conducted in Year 2 of the study from February 14, 1995 to April 4, 1995. Surveys were conducted by one observer aboard a 17' Boston Whaler. Three observation trips per week were conducted, weather permitting, with one simultaneous with the aerial survey. Surveys were conducted in the area of intense ocean shad fishery effort, from Cape Island to Pawley's Island (Figure 2). However, not all of this area could be covered in one day. Four surveys were planned for each island or designated stretch of beach where shad fishing was known to occur. Sea state was important in determining which section of the shad fishery area was to be surveyed on any given day. Boat docks where shad fishermen departed were checked for activity. If there was high activity, then that area corresponding with the dock was surveyed. The location of shad boats, nets, and marine mammals were documented using a Loran C. Observations recorded included fishing methods used, areas fished, catch and bycatch, and marine mammal interactions (see Appendix A). Loran C coordinates were taken at the offshore end of the nets to define areas fished. All marine mammal sightings were recorded, including numbers, behavior, direction of travel, and Loran C coordinates for each sighting.

### Description of Ocean Shad Fishery

A description of the fishery was provided by conducting interviews with the shad

fishermen and by observer coverage. The interviews were conducted at fish markets, docks, boat ramps, and while at sea. Interviews of each fisherman included questions about net construction, cost of gear, operating expenses, fishing methods, characteristics of the area fished, problems encountered, and observed behaviors (e.g. - direction of travel, surface or bottom movements, etc.) of shad in relation to changing environmental conditions. A daily fishing log of the entire season provided by one fisherman, and observations of eight hauls formed the basis of catch per unit effort (CPUE) formula. Catch per unit effort (CPUE) was computed from the observed hauls (Table 1). The hours the net is in the water is recorded in whole hours, the catch as number of fish, and the net length in yards. The formula used to compute the CPUE is:

$$C = \frac{s}{y/100 \times h}$$

where, C = number shad/100 yds./hr.

s = number shad caught

y = length of net in yards

h = hours fished

## RESULTS

### Aerial Surveys

**Year 1:** Ten aerial surveys totalling 33.5 hours of flight time ( $\bar{x}$  = 3.35 hrs/survey), were conducted from January 20 to April 14, 1994 (Table 2). One of these surveys was not completed due to inclement weather. Seven of the surveys occurred during the shad fishery season,

totalling 22.5 hours ( $\bar{x}$ = 3.21 hrs/survey) of flight time. The remaining three surveys, totalling 10 hours ( $\bar{x}$ = 3.3 hrs/survey), consisted of a preliminary flight before the shad season opened, and two post -shad season surveys. The pre- and post - shad season surveys were used to detect out-of- season fishing, strandings, and presence of dolphins.

Three cetacean strandings were sighted during the aerial surveys. Five additional cetacean strandings were reported through the SEUS Stranding Network Volunteer Program (Table 3). These five strandings occurred on non-survey days and were outside of the fishery area.

The cause of death of the lone bottlenose dolphin (SC9405) stranded in the area of effort in Year 1 of the study could not be determined. This animal was necropsied by SCDNR personnel on the South Island beach. Two creases along either side of the head around the neck were first thought to be fishery related. However, given the condition code of the animal, it was suggested that these creases may have been naturally occurring as the skin dried and cracked along the folds of the neck. Shad nets were not observed off South Island on the day of this stranding (Appendix B, No. 5), but South island was within the area of the fishery. The state of decomposition suggested that this animal had been dead for at least a day, taking into consideration that temperatures in March were approximately 50°F during the day and colder at night. Therefore, it was unknown if this stranding was fishery related.

Two animals which stranded dead in Myrtle Beach were potentially close to the shad fishery nets, although no nets were observed off of Myrtle Beach in either year of the study. SC9406 was a spotted dolphin (*Stenella frontalis*) which stranded 10 March 1994. The necropsy of this animal revealed that the dorsal fin had a 7.6 cm straight-line cut which nearly severed the

fin, a circular hole in the dorsal fin, a hole in right lateral side of the tail stock, and a large bruised area posterior to the right flipper. The state of decomposition suggest that this animal died offshore and stranded several days or more after death. Spotted dolphins are not normally found near shore; known distribution patterns suggest that, if death was fishery related, an offshore fishery was likely involved. The other animal, a bottlenose dolphin (SC9404), stranded in Myrtle Beach on 7 March 1994 and was in advanced stage of decomposition. No evidence of fishery interaction was observed and determination of cause of death was not possible.

Two hundred fifty five free-swimming dolphins comprising 137 groups ( $\bar{x}$  = 1.86 dolphins/group, range = 1 to 7) were sighted in Year 1 of the aerial surveys. Approximately 77% (n=196) of these dolphins were sighted during the shad fishery season. Of the 255 dolphins observed, 52 dolphins were observed in the area of shad fishery effort (Appendix B). Thirty-two of these dolphins were sighted during the shad fishery season. Only one of these dolphins was in close proximity to a net. This animal was observed 24 March 1994 moving south towards a net stationed off Bull Island. It was unknown if any interaction between this animal and the net occurred. Other notable sightings included a harbor seal (*Phoca vitulina*), observed hauled out, alive, on Cummings Point, Morris Island on March 24th and, two leatherback sea turtles (*Dermochelys coriacea*), one observed off of Edisto Beach, and the other off of Bulls Island on April 14th.

A total of 50 shad nets and 23 shad boats were observed during the shad fishing season, February 1 to April 2, 1994. Nets occurred from Bulls Island to Debordieu Beach, a distance of approximately 66 km (36.5 nmi), with 92% of the nets being set between Cape Island and Debordieu Beach (Table 4), approximately 38 km (20.5 nmi). The majority of nets were set off

Cape Island (44%), with fewer off South Island (18%), Cedar Island (16%), and Debordieu Beach (14%). Nets were sighted on 75% of the days surveyed off Cape Island, 62.5% off Debordieu Beach, and 50% each off Cedar and South Islands. Figure 3 shows the location of nets in relation to the location of sightings. Nearly all sightings occurred beyond the area of shad fishery effort.

A total of 114 shrimp boats was observed and only one dolphin was observed associated with a shrimp boat.

**Year 2:** Fourteen aerial surveys, totalling 55 hours ( $\bar{x}$ = 3.93 hrs/survey), were conducted from January 27 to April 18, 1995 (Table 5). Two of these surveys were not completed due to inclement weather. Twelve of the above surveys were conducted during the shad fishery season, totalling 48.25 hours ( $\bar{x}$ = 4.02 hrs/survey) of flight time. The remaining two surveys consisted of one pre- and one post- shad fishery season survey, totalling 6.75 hours ( $\bar{x}$ = 3.37 hrs/survey) of flight time.

Two cetacean strandings were sighted during the aerial surveys. Eight additional cetacean strandings were reported through the SEUS Stranding Network Volunteer Program (Table 6). One of the 8 strandings occurred on a survey day. One of the dolphin strandings observed during the surveys was in the area of shad fishery effort. Of the other 8 dolphin strandings reported by the SEUS Stranding Network, only two were in the area of shad fishery effort.

As mentioned above, three dolphins stranded in the area of fishery effort in Year 2 of the study. SC9504, a bottlenose dolphin, was reported stranded on South Island, 6 February 1995. This animal was mummified with very little skin and mostly bones remained. No evidence of

fishery interaction was observed and cause of death was not determined due to the advanced state of decomposition. SC9502, a bottlenose dolphin, stranded on Bull Island 7 February 1995. This animal was a late code 3 animal with leathery skin. Stomach content analysis revealed fish, squid, and shrimp (Dr. Nelio Barros, personal communication, Sea World, Inc.), suggesting that this dolphin had been eating shortly before death. No evidence of fishery interaction was observed and cause of death was not determined due to the advanced state of decomposition. No shad nets were observed off of Bull Island on February 7 (Appendix C, No. 3). Shad nets were not observed during surveys prior to February 7. SC9507, a bottlenose dolphin, stranded on the south end of Pawley's Island near Pawley's Inlet on 21 March 1995. This animal was severely decomposed and no evidence of fishery interaction was observed. One net was observed off Debordieu Beach on March 21 (Appendix C, No.9), 2.8 km (1.5 nmi) south of Pawley's Island, but the state of decomposition would suggest that this animal had been dead for some extended period of time. Nets were observed off Debordieu Beach on all surveys prior to March 21.

During Year 2 there was another stranding in Myrtle Beach which was suspected to be fishery related. SC9503 was a bottlenose dolphin which stranded dead 7 February 1995. The nearest nets observed to the stranding location were deployed off Debordieu Beach, approximately 42.6 km (23 nmi) south of the stranding site, on 7 February (Appendix C, No.3). This animal was a freshly dead animal which allowed for the collection of histology samples. We suspected that this animal was involved in some fishery interaction due to parallel lacerations on the ventral right flipper, a thin parallel line on the ventral left flipper, and a laceration parallel to the axis of the body on the right fluke. However, histological results did not confirm this speculation. These results, provided by the AFIP, indicated that the primary cause of death was

necrotizing myocarditis possibly caused by a bacterial infection. The report also concludes that she could not meet her nutritional needs as evidenced by atrophy of adipose tissue, which caused her emaciated appearance. Stomach content analysis revealed small traces of fish, squid, and a piece of monofilament line (Dr. Nelio Barros, personal communication, Sea World, Inc.).

SC9406 described above, also had similar markings.

More than 495 free-swimming dolphins comprising 246 groups ( $\bar{x}$  = 2.0 dolphins/group, range = 1 to 4) were sighted during Year 2 of the aerial surveys. Of the 495+ dolphins observed, 40 were observed in the area of shad fishery effort (Appendix C). Approximately 72% (n=358) of these were sighted during the shad fishery season. Thirty-five of the 40 dolphins observed in the area of shad fishery effort occurred during the shad fishery season. Eighteen of these were observed offshore at least 1.6 km (.9 nmi) from the nets. Those results were similar to those of Year 1 (see Appendix C). No dolphin was observed in close proximity to a net. Other notable sightings included 37 leatherback sea turtles, 29 loggerhead sea turtles (*Caretta caretta*), and numerous schools of cow-nose rays (*Rhinoptera bonasus*).

A total of 105 shad nets and 70 shad boats were observed during the shad fishery season, February 1 to April 15, 1995. Nets occurred from Cape Romain to Garden City Beach, a distance of 74 km (40 nmi), with 87.5% of the nets being set between Cape Island and Debordieu Beach (Table 7). The majority of nets were set off of Cape Island (31.4%), with fewer off North Island (22.8%), Debordieu Beach (19.0%), and South Island (14.3%). Nets were sighted on 90.9% of the days surveyed off Cape Island, 81.8% off Debordieu Beach, 72.7% off South Island, and 54.5% off North Island. All data was recorded for each survey in a database (Appendix D). Figure 4 relates dolphin sightings with net locations. Nearly all

sightings occurred beyond the area of shad fishery effort.

A total of 126 shrimp boats was observed and 6 dolphins were observed associated with 3 of these shrimp boats.

The total area observed fished for both years was from Bull Island to Garden City Beach, a total of approximately 95 km (51 nmi). However, the range of nets differed: from Bull Island to Debordieu Beach, a total of approximately 68 km (37 nmi), during Year 1, and from Cape Romain to Garden City Beach, a total of 74 km (40 nmi), during Year 2. Survey effort doubled in Year 2 due to the extension of flights to the Georgia-South Carolina border and to the North Carolina-South Carolina border.

#### Boat Surveys

Boat surveys were conducted only during Year 2 of the study. One of the three boat surveys per week was conducted in conjunction with the weekly aerial survey. Surveys were conducted beginning the third week of the shad fishery season. A total of 16 surveys were completed, and 150 nets were observed (Appendix E). Six other surveys were aborted due to mechanical failure (2) and sea or weather conditions (4). At-sea observations accounted for 99 hours of effort. The surveys were conducted off North Island (7 days), South Island (6 days), Debordieu Beach (6 days), and Cape Island (5 days). Some surveys incorporated more than one area on the same day.

Bottlenose dolphins were observed on 9 of the 16 shad fishery surveys; a total of 38 dolphins was seen in 21 sightings (Appendix F). Bottlenose dolphins were observed in the Winyah Bay entrance shad fishing exclusion zone, North Inlet, and Jones Creek, but were not observed in close proximity to ocean shad fishery operations.

The CPUE ranged from 0.25 to 4.7 for eight observed hauls (Table 1). The CPUE obtained from daily records of one fisherman was 1.1, within the above range. There were problems in collecting information for estimating CPUE. Efforts to obtain catch and bycatch data accurately were impaired by the techniques used during the haul of the shad nets. Often, only part of the net would be hauled or fish removed from areas that indicated catch, which made accurately measuring net length problematic. Occasionally, an accurate count of bycatch was not possible when fishermen would shake the net as it emerged from the water. Accurate soak times were difficult to obtain in areas where nets were frequently reconfigured. Fishermen's reported soak time were verified by the observed soak times. Soak times were rounded to whole hours for all CPUE computations.

No marine mammal or sea bird fishery interactions were observed during the boat surveys, and none were reported by fishermen. The observed bycatch was less than expected from interviews with the fishermen and the SCDNR researchers. Bycatch included menhaden (*Brevoortia tyrannus*), hickory shad (*Alosa mediocris*), and smooth dogfish (*Mustelis canis*). Nets made with #3 (.28 mm diameter) twine were reported by fishermen to have the most bycatch. Nets made of #4 (.33 mm diameter) twine were reported by fishermen to catch well, have good durability, but were reported to have menhaden bycatch. The #6 (.40 mm diameter) twine was preferred by most fishermen for selectivity of catch, reduced menhaden catch, ease of bycatch removal, and good durability (Table 8).

#### Description of Ocean Shad Fishery

Forty-eight interviews were conducted with fishermen (23), fish house or market personnel (15), and the SCDNR personnel (10), totalling 50 hours, to understand the fishery.

Nine full-time and five part-time ocean shad fishermen were identified in South Carolina. Most of these fishermen reside in Georgetown and worked nets in teams or in family units. Tide stage and weather conditions were the major factors determining where the fishermen fished.

The vessels used in the ocean shad driftnet fishery were 17 to 23 feet long, made of wood or fiberglass, and powered by outboard motors from 70 to 175 horsepower. Some shad boats had a PVC hoop attached at both sides of the boat near the stern for setting the net. Boats were deployed from a fish house in Georgetown, the McClellanville public ramp, the South Island public ramp, the Georgetown public ramp, and Pawley's Island public ramp.

The shad driftnets were constructed from 5 ½ inch stretch mesh, #4 or #6 monofilament webbing, from 20-60 meshes deep, and were from 200-2000 yards long. The nets were typically constructed in 300 yard detachable segments referred to as a "shot of net". The webbing was suspended on a cork line, made from ¼ to 5/16 inch braided polypropylene line with a ¾ to 1½ inch drop. The floats were tied from two to six yards apart and a large red float was placed every 100 yards, as was required by South Carolina fishing regulations. The lead line was made from ¼ inch (#8) to 5/16 inch (#10) braided polypropylene line into which lead inserts were placed at 0.8 to 2.0 ounces per yard or a lead core line weighing 2.5 or 1.6 ounces per yard is used.

Nets were set from the shore to offshore, typically with the inshore end as close to the breaker line as possible. The nets were actively fished by reconfiguring the net or moving it inshore or offshore, depending on where the fish were being caught. Nets that were catching the most shad inshore may have been reconfigured by disconnecting an offshore shot of net and setting this section close to shore. The same was true for shad being caught more offshore. The duration of soak time depended on wind, surf, current, and number of shad caught. A data log

provided by one fisherman recorded 183 hours of net soak time over 27 days fished, an average of approximately 7 hours of soak time per day.

Shad fishing is allowed in South Carolina from noon Monday to noon Saturday with all fishing occurring during the day. Catch in the ocean shad driftnet fishery usually diminishes before the official closing date (ASMFC, 1985). Prices also usually decline as the season progresses. For example, in 1994 the price per pound for buck (male shad) declined from \$0.43 in February to \$0.36 in April. Similarly, in 1994 the price per pound for roe (female shad) declined from \$1.41 in February to \$0.94 in April. As catches and prices decline the fishermen move into the estuaries to fish for shad or turn to alternative fisheries.

## DISCUSSION

The shad fishery operated along the coast of South Carolina from Bulls Island to Garden City Beach, with more effort occurring in the central portion of the study area. There was a shad fishery exclusion zone at the Winyah Bay entrance (Figure 2). Dolphins were sighted all along the coast, but nearly all were sighted more than 15 km (8.1 nmi) northeast and southwest, and 1.6 km (.9 nmi) southeast of the fishing operations. The opportunity for interactions did exist, but our observations indicated that interactions were a rare occurrence. Strandings did occur in the shad fishery areas, but none were conclusively shown to be fishery related.

Since aerial surveys and boat surveys did not provide the opportunity to follow observed dolphins for a long period of time, we could not determine the movements of dolphins sighted. However, bottlenose dolphins are capable of traveling 30-50 km (16 nmi-27 nmi) or more per day, and could have moved into shad fishery areas where the potential for fishery interaction

existed. Net soak times were of long duration, increasing the likelihood of interaction. Net soak time and proximity of nets to shore were two of many factors identified by a sub-group of cetacean researchers at The Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps (IWC, 1994), as being increased risk factors for entanglement. As previously mentioned, only one dolphin was observed in close proximity to a net. The dolphin was circled, but soon disappeared and was not relocated.

Regulations placed on the ocean shad fishery have likely reduced the number of incidental takes of bottlenose dolphins, however, the exact number, if any, of dolphins that become entangled each year in ocean shad nets is still unknown. It was anticipated that quick response to dead stranded animals and determination of cause of death would provide insight into this question. However, the dolphins which did strand in the area of shad fishery effort were too decomposed to determine cause of death. Their state of decomposition suggested that they had been dead and probably afloat at sea for several days or more before stranding. We suspect that a dolphin which died from an entanglement close to shore, as in the ocean shad fishery, and stranded soon after would be relatively fresh (code 2 or early code 3) when examined. This was not the case with the animals we examined. The cold water temperature, typically 10°C at this time of year, would also slow the decomposition process. Further, stomach contents were analyzed for only one dolphin stranded within the area of shad fishery effort, which made determining whether these animals were feeding at time of death, difficult. We assume that a stranded dolphin with a full stomach was eating shortly before death. If the dolphin was feeding at the time of entanglement we would presumably see food in the stomach.

During the study period in 1994 and 1995 a total of 18 marine mammal strandings

occurred in South Carolina (Figure 5). Of these, four were in the area of shad fishery effort, and three were just outside of this area in Myrtle Beach. This was not unusual compared to the prior two years. During the same period in 1992 and 1993, a total of 14 marine mammal strandings occurred in South Carolina. Three of these were in the area of shad fishery effort, but cause of death could not be determined.

Documentation of marine mammals as bycatch in the South Carolina ocean shad drift gillnet fishery has been sparse. Marine mammal entanglements have been observed in other shad fisheries along the east coast of the U.S., most notably of harbor porpoise (*Phocoena phocoena*) (Polacheck, et al., 1994). Humpback whales (*Megaptera novaeangliae*) have been entangled in shad nets off Virginia, but this is an unusual occurrence in the shad fishery (Read, 1994). In South Carolina, Burn and Scott (1988) reported that an estimated 12-15 bottlenose dolphins were incidentally taken each year in sturgeon and shad gill nets. The majority of these animals were probably taken in the sturgeon fishery (Read, 1994). This estimate was provided by Reynolds (1985) in 1985, the year the oceanic sturgeon fishery closed indefinitely.

With the closure of the oceanic sturgeon fishery and an amendment to Section 50-17-1022 of the Code of Laws of South Carolina, incidental take of bottlenose dolphins in gill nets was reduced to two animals in 1985 (Reynolds, 1985). Briefly, this Amendment stated that "... all nets must be drift fished and may not be staked, anchored, or otherwise set in a fixed position", and " No gill net used in the waters of the Atlantic Ocean may be left unattended ...". Since 1985, only a few instances of bottlenose dolphin entanglements have been reported.

A Marine Biologist with the SCDNR for 10 years has described two instances of gill net entanglement. One dolphin was observed with its tail wrapped in a gill net line ¼ mile off North

Island in 1988. The second occurrence involved two animals, mother and calf, entangled in a gill net in the surf of Garden City Beach during the winter of 1990. All of the above dolphins were released unharmed (Dean Cain, personal communication, SCDNR).

Two interviewed fishermen, with a combined 57 years of shad fishing experience, had personal knowledge of three bottlenose dolphin entanglements. Both fishermen attributed the entanglements to conditions which made it difficult for dolphins to detect the presence of nets. One fisherman described the dolphins as chasing a food source, menhaden, into the net, with one dolphin becoming entangled. This animal was released unharmed. Au (1994) presented a similar scenario that would prevent dolphins from acoustically sensing the presence of the net due to masking of the net by a school of fish. The other fisherman described two instances of entanglements that occurred during extreme northeasterly winds. The fisherman speculated turbidity of the water was responsible for the animals not detecting the nets. He also inferred that the dolphins did not survive. Cockroft and Ross (1991) attempted to address the effects of turbidity on the incidence of dolphin entanglement, but found this difficult to quantify. The sea conditions may affect dolphin acoustic ability; turbid water may produce persistent bubbles to a depth of several meters which form excellent echolocation deflectors and thereby block acoustic detection of the net (IWC, 1994).

Interviews with the shad fishermen and SCDNR personnel suggested that fish bycatch was lower in 1995 than in previous years. This may indicate that dolphin prey species that may have been commonly caught in shad nets in previous years, may not have been present in the shad fishery areas during the study period. This could have caused the dolphins to forage elsewhere, thereby reducing the likelihood of interactions between dolphins and the fishery.

Cockroft and Ross (1990) suggested that dolphin entanglement may be linked to changes in prey movements which are influenced by currents.

## CONCLUSIONS

The South Carolina ocean shad drift gillnet fishery was determined to be consistent with a Category III fishery as described in Read (1994); unlikely to take marine mammals during the course of its operations. Observations made during the two years of surveys determined that while strandings of dead marine mammals occur occasionally in the area of shad fishery effort during the shad fishery season, none showed strong evidence of fishery interaction or were too decomposed to determine if fishery interaction occurred.

Interactions between marine mammals and shad nets were not observed, except for one instance when a dolphin was seen near a net, although dolphins were present in the shad fishery region during February to April. Interviews with fishermen seem to corroborate this finding. Only a few were noted by fishermen where interaction occurred, and environmental factors, such as turbidity and following a food source, appeared to be a factor in causing the interaction. Environmental factors may have a major impact on the risk of entanglement in any given year.

This fishery appears to be a declining fishery with little impact on marine mammal mortality. Further investigation into bottlenose dolphin population estimates during this time of year would aid in determining allowable incidental takes by this fishery. Also, repetitive surveys over a number of years may show the impact environmental factors have on the risk of dolphin entanglement. Investigation into other fisheries that may cause marine mammal mortality in this region is necessary to account for those stranded animals with suspicious markings.

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FIGURE 1. Aerial survey flight patterns. 1994 surveys shown in broken lines starting at Walterboro Airport (WA). 1995 surveys shown in solid lines starting at Charleston Executive Airport (CEA).

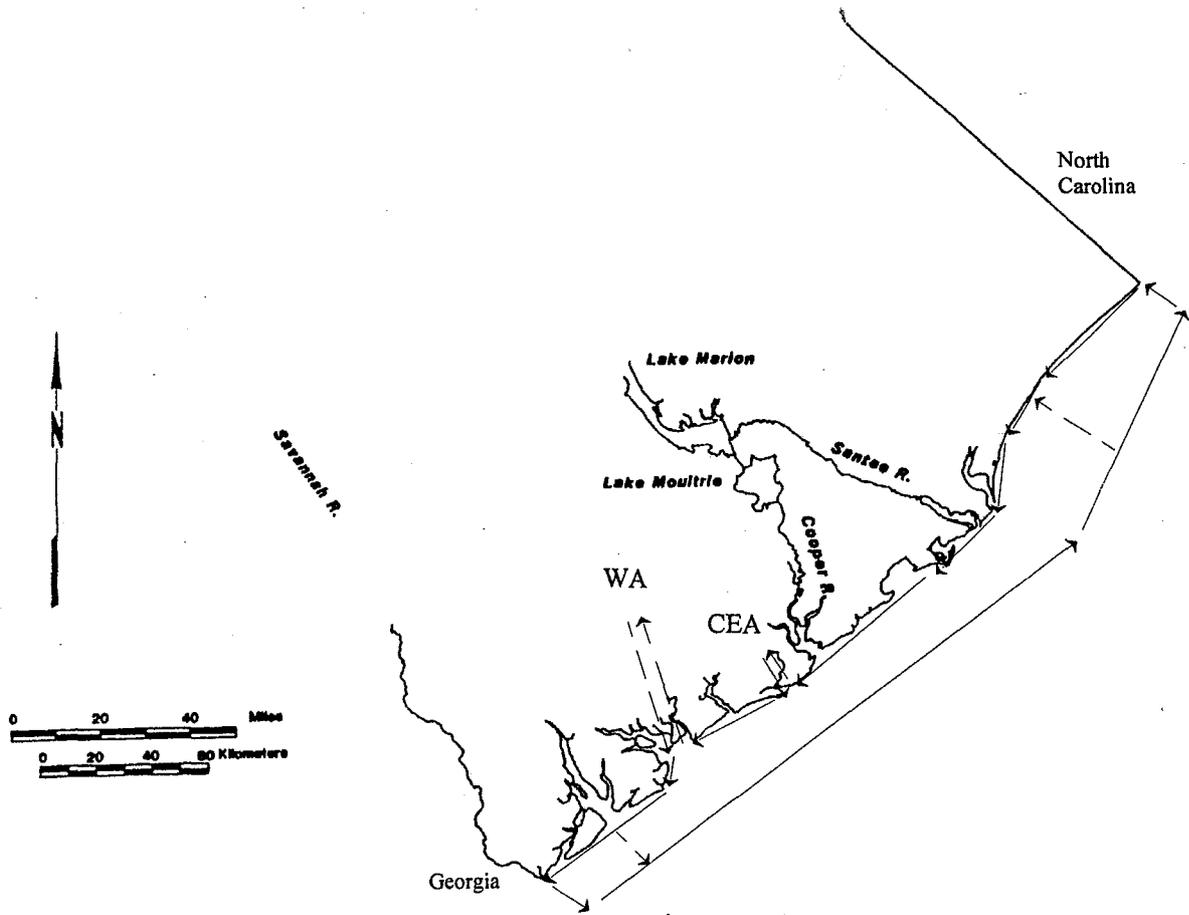


FIGURE 2. Boat survey study area of ocean shad driftnet fishery, including shad fishing exclusion zone.

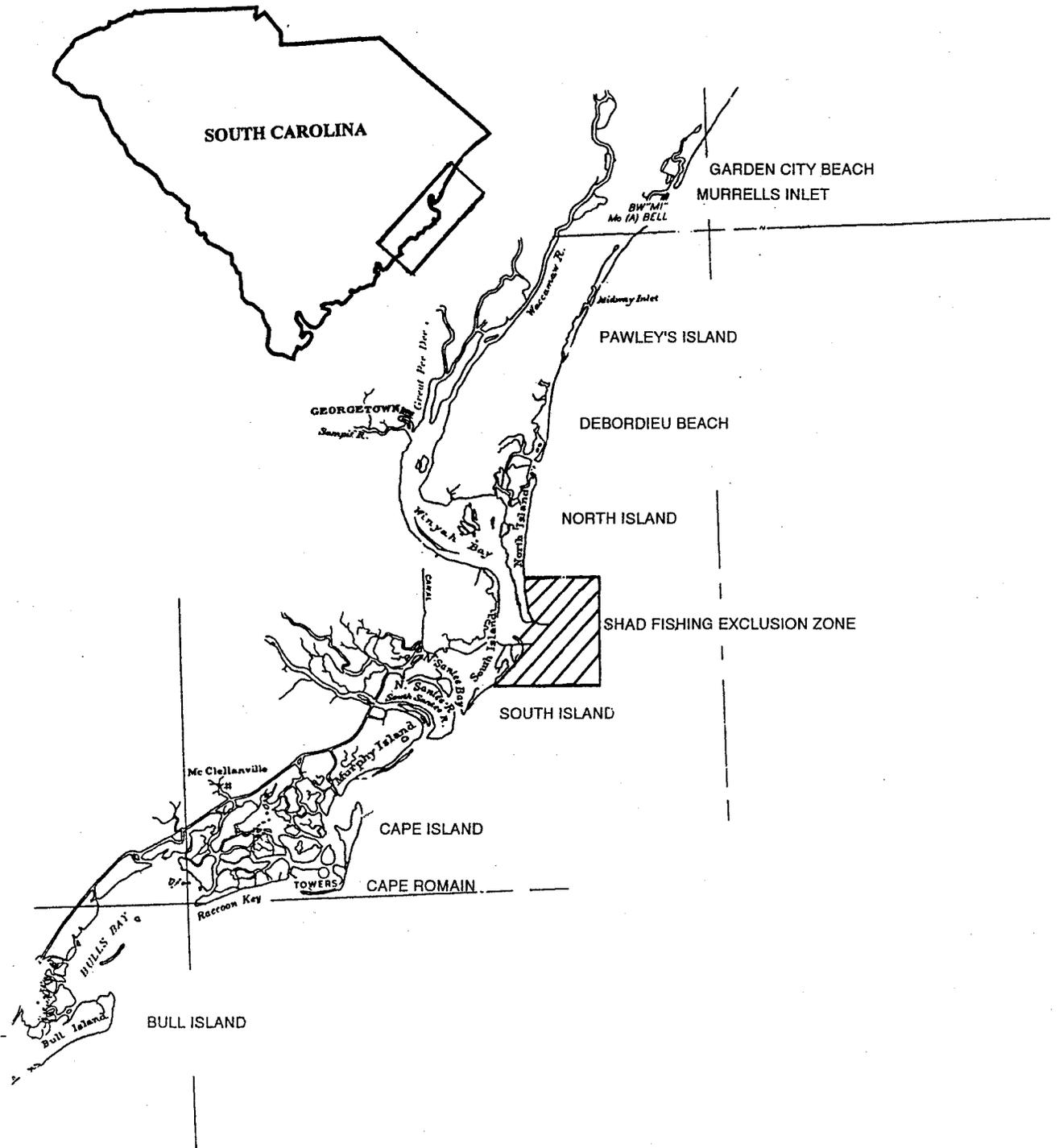


FIGURE 3. Locations of dolphins and locations of shad nets sighted in shad fishery area during Year 1 aerial surveys. Percentages indicate percent of the total nets sighted in a given area. The dotted line represents the flight path which was 1.6 km offshore. Numbers represent locations and number of dolphins in each sighting.

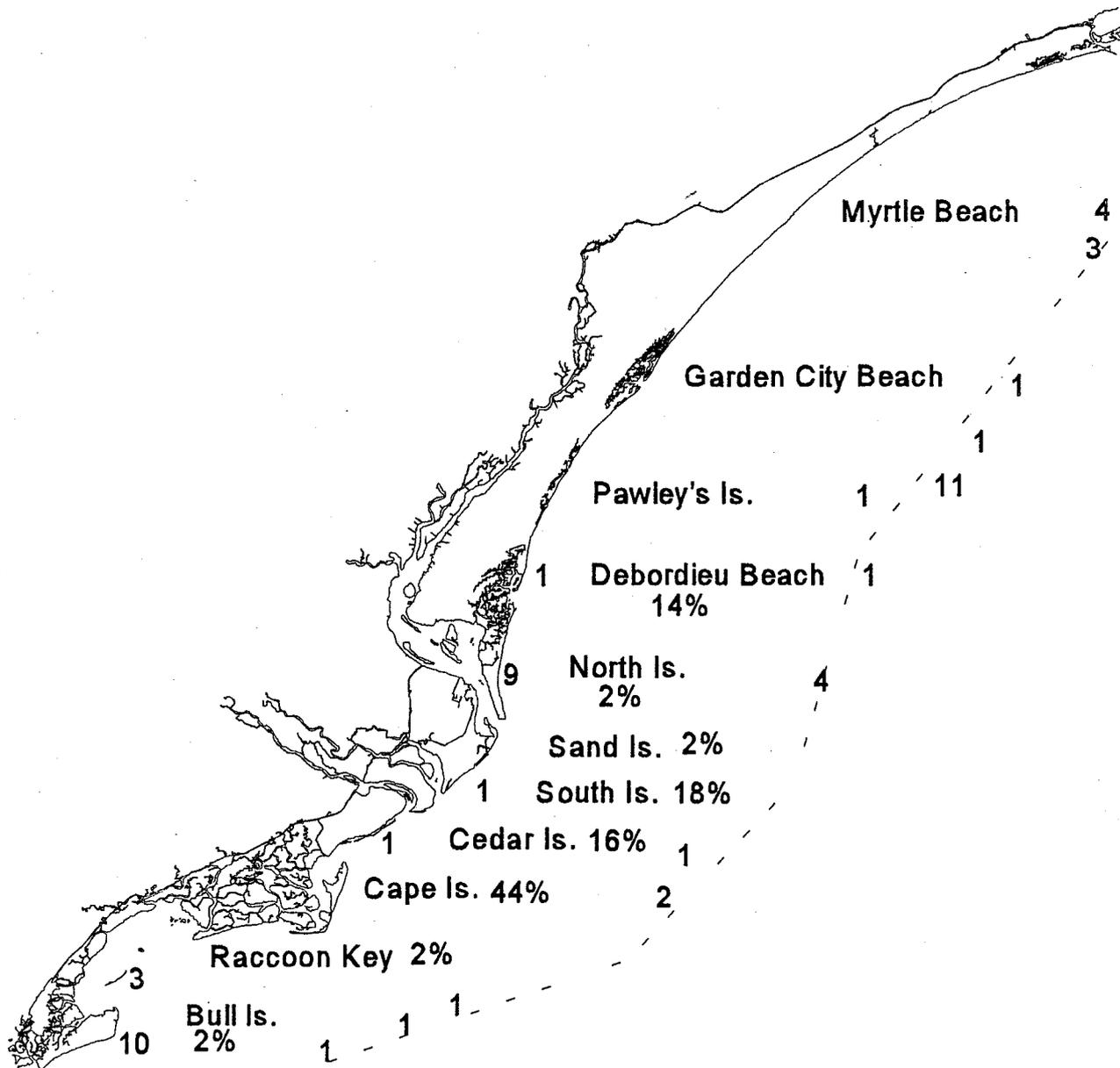


FIGURE 4. Locations of dolphins and locations of shad nets sighted in shad fishery area during Year 2 aerial surveys. Percentages indicate percent of the total nets sighted in a given area. The dotted line represents the flight path which was 1.6 km offshore. Numbers represent location and number of dolphins in each sighting.

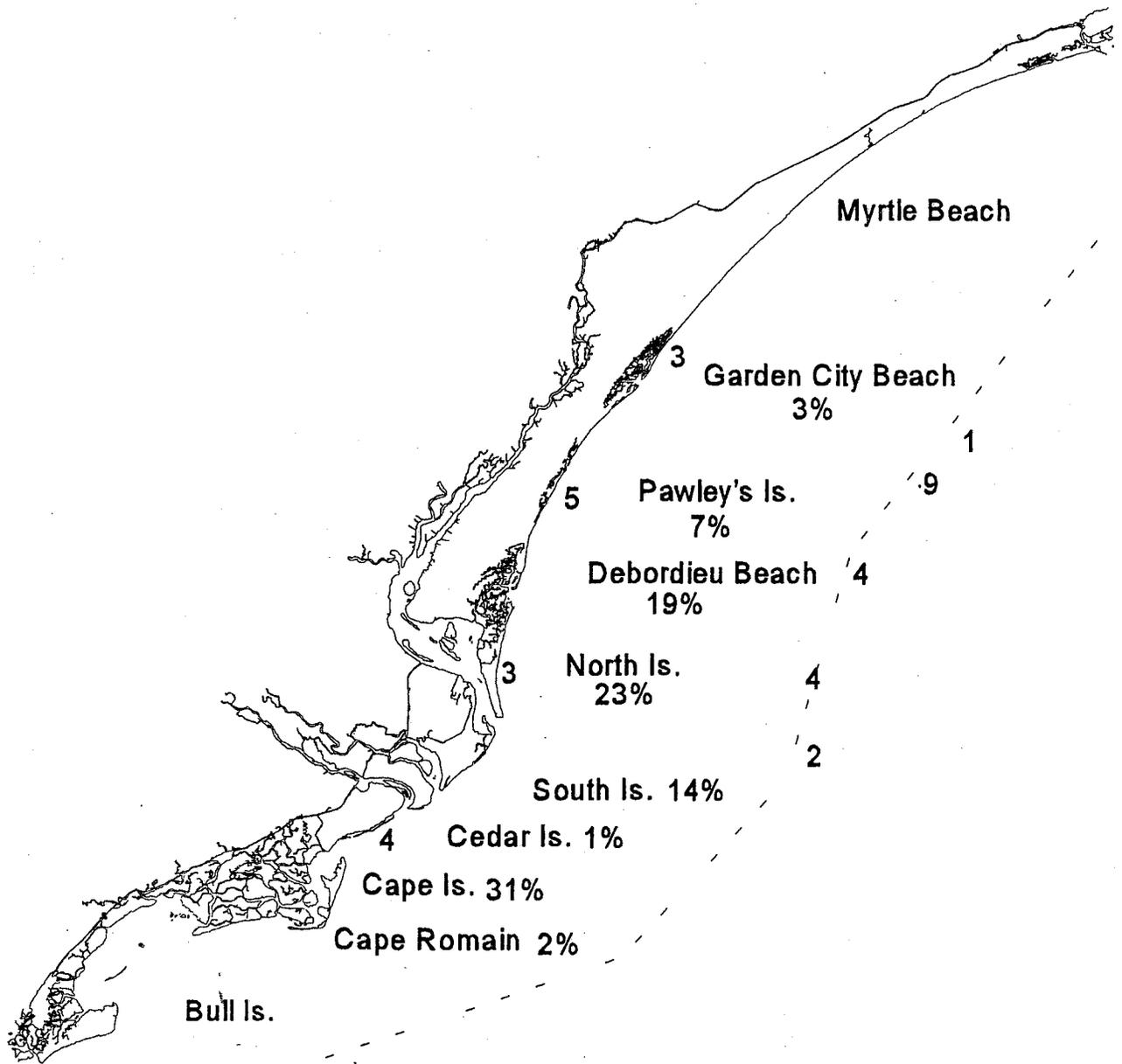
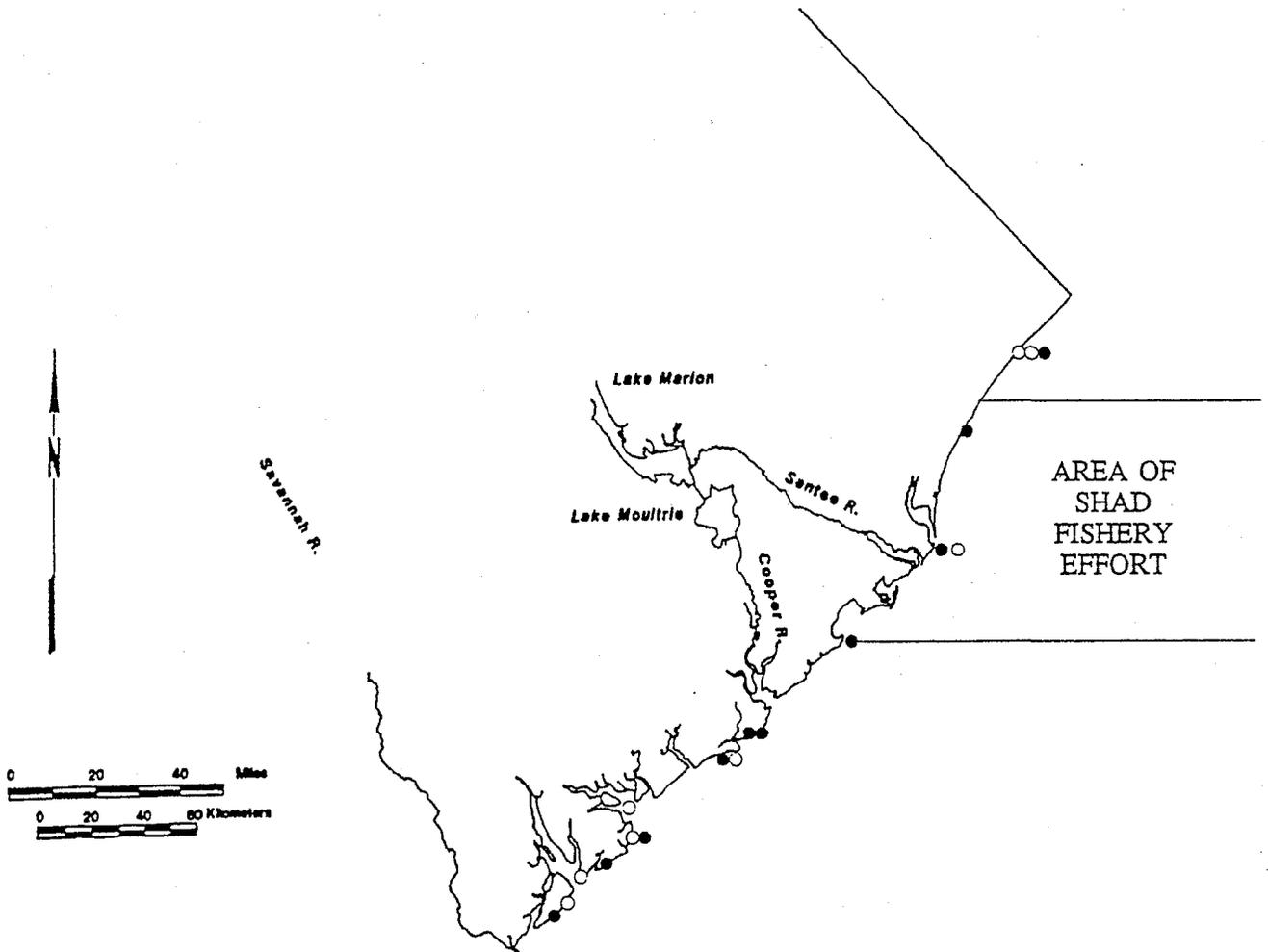


FIGURE 5. Marine mammal strandings in South Carolina during the shad fishery season (February - April), for 1994 and 1995. 1994 strandings are represented by open circles. 1995 strandings are represented by closed circles.



**Table 1. Observed CPUE in the ocean shad driftnet fishery.**

Net hauls were selected for CPUE based on an accurate net length determination, method used to retrieve the net, uninterrupted view, and genus identification. Only hauls where the total length of the net was exposed were used.

Number of hauls observed----- 20  
 Hauls selected for CPUE----- 8  
 Total yards of net for 8 observed hauls----- 3250  
 American shad caught----- 134

LENGTH OF NET IN YARDS	SOAK TIME IN HOURS	NUMBER OF SHAD CAUGHT	CPUE IN # SHAD PER 100 YARDS PER HOUR
150	2	6	2.0
500	2	14	1.4
800	2	75	4.7
500	2.5	25	2.0
500	2	3	0.3
500	2	8	0.8
200	2	1	0.25
100	2	2	1.0

**Table 2. Year 1 aerial survey sightings of number of live bottlenose dolphins, strandings, shad nets, shad boats, and shrimp boats.**

Date	# live dolphins	# strandings	# shad nets	# shad boats	# shrimp boats
1/20	3	0	0	0	0
2/3	3	0	10	7	0
2/15	25	0	13	5	17
2/28	4	0	0	0	9
3/8*	NR	2	4	NR	NR
3/15	33	1	11	5	28
3/17	55	0	8	5	36
3/24	48	0	1	0	13
3/31	43	0	3	1	3
4/7	5	0	0	0	3
4/14	36	0	0	0	5
TOTALS	255	3	50	23	114

\* Not part of a planned survey, but was reported from the SCWMRD on aerial survey related to eagle nest study.  
 NR= not reported

**Table 3. Year 1 cetacean strandings in South Carolina with locations and evidence of fishery/human interaction.**

Date	Species	Location	Fish/Human Int.
2/25	<i>Globicephala macrorhynchus</i>	Kiawah Is.	N
2/28	<i>Tursiops truncatus</i>	St. Helena Snd.	N
3/7	<i>Tursiops truncatus</i>	Myrtle Beach	N
3/8	<i>Tursiops truncatus</i>	*South Is.*	?
3/10	<i>Stenella frontalis</i>	Myrtle Beach	Y
3/15	<i>Kogia breviceps</i>	Bay Point	N
3/16	<i>Tursiops truncatus</i>	Hiton Head Is.	Y
3/28	<i>Tursiops truncatus</i>	Hunting Is.	N

\* - indicates stranding in area of shad fishery effort

**Table 4. Summary of Year 1 aerial survey fishery sightings by location of nets and boats, percentage of nets, and percentage of days sighted.**

Location	# Nets	# Boats	# days flown	# days nets sighted	% Nets	% days sighted
Debordieu Beach	7	4	8	5	14.0	62.5
North Is.	1	1	8	1	2.0	12.5
South Is.	9	5	8	4	18.0	50.0
Cape Is.	22	9	8	6	44.0	75.0
Cedar Is.	8	3	8	4	16.0	50.0
Bull Is.	1	0	8	1	2.0	12.5
Raccoon Key	1	1	8	1	2.0	12.5
Sand Is.	1	0	8	1	2.0	12.5
TOTAL	50	23	N/A			

**Table 5. Year 2 aerial survey sightings of number of live bottlenose dolphins, strandings, shad nets, shad boats, and shrimp boats.**

Date	# live dolphins	# strandings	# shad nets	# shad boats	# shrimp boats
1/27	34	0	0	0	24
2/1	27	0	13	8	2
2/7	11	1	10	7	0
2/14	27	0	11	9	8
2/21	10	0	18	12	7
2/28	37	0	0	0	6
3/3	12	0	9	8	4
3/7	65	0	7	4	25
3/14	40	0	18	9	11
3/21	25	1	6	5	11
3/28	70	0	7	6	15
4/4	17+	0	6	3	7
4/12	17	0	0	0	0
4/18	103+	0	0	0	6
TOTALS	495+	2	105	71	126

**Table 6. Year 2 cetacean strandings in South Carolina with locations and evidence of fishery/human interaction.**

Date	Species	Location	Fish/Human Int.
2/6	<i>Tursiops truncatus</i>	*South Is.*	?
2/7	<i>Tursiops truncatus</i>	*Bull Is.*	?
2/7	<i>Tursiops truncatus</i>	Myrtle Beach	Y
2/20	<i>Tursiops truncatus</i>	Hunting Is.	N
3/18	<i>Tursiops truncatus</i>	Pritchard's Is.	?
3/21	<i>Tursiops truncatus</i>	*Pawley's Is.*	?
3/29	<i>Tursiops truncatus</i>	Kiawah Is.	N
4/5	<i>Tursiops truncatus</i>	Folly Beach	Y
4/9	<i>Tursiops truncatus</i>	Folly Beach	?
4/11	<i>Tursiops truncatus</i>	Hilton Head Is.	N

\* - indicates stranding in area of shad fishery effort

**Table 7. Summary of Year 2 aerial survey fishing sightings by location of nets and boats, percentage of nets, and percentage of days sighted.**

Location	#Nets	#Boats	#days flown	#days nets sighted	%Nets	% days sighted
Debordieu Beach	20	18	11	9	19.0	81.8
North Is	24	10	11	6	22.9	54.5
South Is	15	11	11	8	14.3	72.7
Cape Is	33	20	11	10	31.4	90.9
Pawleys Is	7	6	11	3	6.7	27.2
Garden City Bch	3	3	11	3	2.9	27.2
Cape Romain	2	1	11	1	1.9	9.1
Cedar Is	1	0	11	1	0.9	9.1
<b>TOTAL</b>	<b>105</b>	<b>69</b>	<b>N/A</b>			

**Table 8. Ocean shad net construction specifications by fisherman and area fished.**

FISHERMAN	HANGING COEFFICIENTS IN MESHES PER INCHES	NET DEPTH IN MESHES	NET TWINE SIZE	FLOAT SPACING IN YARDS	LEAD PER YARD IN OZ. AND LOCATION	AREA FISHED
A	5 ON 11	25 - 35 - 50	#6 (.40 mm dia.)	1/2 In. foam core	1.6 lead core line	North Island
B	6 ON 12	25	#4 (.33 mm dia.)	N/A	N/A	South Island
C	4 ON 8	35 INSHORE 50 OFFSHORE	#4 (.33 mm) #6 (.40 mm)	6	2.0 1 per yard	Debordieu Island
D	3 ON 7 4 ON 8 5 ON 12	25	#6 (.40 mm)	5 OR 6	1.0 Two 2 oz. under float, one in center	Cape Island
E	3 ON 6	25 INSHORE 30 OFFSHORE	#6 (.40 mm)	6	1.0 Two 2 oz. under float, one in center	South Island
F	4 ON 8	50	#6 (.40 mm)	2 - 3 - 4	1.5 1 oz., 2 ft. apart	Pawleys Island
G	4 ON 8	40 INSHORE 50 OFFSHORE	#6 (.40 mm)	4	0.5 2 oz., under float	Debordieu Island
H	4 ON 8	25	#6 (.40 mm)	5	1.0 N/A	Cape Romain

**APPENDIX A**

**Aerial and Boat Survey Data Sheets**

**1995 Shad Fishery/Dolphin Entanglement Data Sheet**

Date: \_\_\_\_\_ Observers: \_\_\_\_\_  
 Airport: \_\_\_\_\_ Pilots: \_\_\_\_\_  
 Aircraft: \_\_\_\_\_  
 Time of Take-off: \_\_\_\_\_

Weather Conditions: \_\_\_\_\_  
 Water Color & Turbidity: \_\_\_\_\_  
 Glare: \_\_\_\_\_  
 Sea State: \_\_\_\_\_

Location	GPS	Time	Tursiops	Nets/Boats	Sh.Boats	Misc.Boats
<b>ALONG BEACH:</b>						
Stono & Folly Rvrs & Bird Key						
Kiawah Island						
Seabrook Island						
N. Edisto Rvr & DeVeaux Bank						
Botany Bay Island						
Edingsville Beach						
Edisto Beach						
South Edisto River						
Pine Island						
Otter Island						
St. Helena Sound						
Harbor Island						
Hunting Island State Park						
Fripp Inlet						
Fripp Island						
Pritchard's Island						
Little Capers Island						
Bull Point						
Trenchards Inlet						
Bay Point Island						
Port Royal Sound						
Hilton Head Island						
Calibogue Sound						
Daufuskie Island						
Turtle Island						
<b>OFFSHORE:</b>						
Turtle Island						
Daufuskie Island						
Calibogue Sound						
Hilton Head Island						
Port Royal Sound						
Bay Point Island						
Trenchards Inlet						
Bull Point						

Little Capers Island						
Pritchards Island						
Fripp Island						
Fripp Inlet						
Hunting Island State Park						
Harbor Island						
St. Helena Sound						
Otter Island						
Pine Island						
South Edisto River						
Edisto Beach						
Edingsville Beach						
Botany Bay Island						
N. Edisto Rvr & DeVeaux Bank						
Seabrook Island						
Kiawah Island						
Stono & Folly Rvrs & Bird Key						
Folly Island						
Morris Island						
Charleston Harbor						
Sullivan's Island						
Isle of Palms						
Deweese Island						
Capers Island						
Bull Island						
Bull Bay						
Raccoon Key						
Lighthouse Island						
Cape Romain						
Cape Island						
Cape Romain Harbor						
Murphy Island						
Cedar Island						
South Island						
Sand Island						
Winyah Bay						
North Island						
Debidue Beach						
Pawleys Island						
Litchfield Beach						
North Litchfield Beach						
Huntington Beach State Park						
Murrells Inlet						
Garden City Beach						
Surfside Beach						
Myrtle Beach State Park						
<b>Myrtle Beach: The Dunes</b>						
Briarcliffe Acres						
Atlantic Beach						

Ocean Drive Beach						
North Myrtle Beach						
Waites Island						
<b>ALONG BEACH:</b>						
Waites Island						
North Myrtle Beach						
<b>Myrtle Beach: Ocean Dr Bch</b>						
Atlantic Beach						
Briarcliffe Acres						
The Dunes						
Myrtle Beach						
Myrtle Beach State Park						
Surfside Beach						
Garden City Beach						
Murrells Inlet						
Huntington Beach State Park						
N. Litchfield Beach						
Litchfield Beach						
Pawleys Island						
Debidue Beach						
North Island						
Winyah Bay						
Sand Island						
South Island						
Cedar Island						
Murphy Island						
Cape Romain Harbor						
Cape Island						
Cape Romain						
Lighthouse Island						
Raccoon Key						
Bull Bay						
Bull Island						
Capers Island						
Deweese Island						
Isle of Palms						
Sullivan's Island						
Charleston Harbor						
Morris Island						
Folly Island						
Stono & Folly Rvrs & Bird Key						
<b>TOTALS:</b>						



NET OBSERVATIONS - TYPE I, II, or III - From Observer Boat

COLLECTION NUMBER \_\_\_\_\_

Boat Number	Net Number	Species	Code	Number	Wt (lb)

NOTES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**APPENDIX B**

**Year 1 Aerial Surveys in Area of Shad Fishery Effort:  
Dolphin/Net Observations**

**No. 1****JANUARY 20, 1994 (Preliminary Flight)**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
	Coosaw R.			1
	Eddingsville			1
	New R.			1
<b>Totals:</b>		<b>0</b>	<b>0</b>	<b>3</b>

**No. 2****February 3, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
~10:00	Raccoon Key	1	1	
~10:05	Cape Is.	4	2	
~10:10	South Is.	3	2	
~10:15	North Is.	1	1	
~10:25	S. Debordieu Bch.	1	1	
<b>Totals:</b>		<b>10</b>	<b>7</b>	<b>0</b>

**No. 3**  
**February 15, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
9:32	Dewees/Capers			2 (offshore)
~10:15	Debordieu Bch.	1	1	
~10:25	Sand Is.	1	0	
~10:27	South Is.	1	0	
~10:30	South Is.	2	1	
~10:35	Cedar Is.	2	1	
~10:40	Cape Is.	2	1	
~10:40	Cape Is.	4	1	
<b>Totals:</b>		<b>13</b>	<b>5</b>	<b>2</b>

**No. 4**  
**February 28, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
<b>Totals:</b>		<b>0</b>	<b>0</b>	<b>0</b>

**No. 5**  
**\*March 8, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
	Debordieu Bch.	1	NR	
	Cedar Is.	1	NR	
	Cape Is.	2	NR	
<b>Totals:</b>		<b>4</b>	<b>NR</b>	<b>0</b>

NR = not recorded

\* = Not a scheduled flight. Recorded by SCDNR on eagle survey.

**No. 6**  
**March 15, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
10:08	Cape Is.	2	1	
10:09	Cape Is. north	2	1	
10:11	Cedar Is.	3	1	
10:13	South Is.	1	1	
10:19	Debordieu Bch.	3	1	
10:21	Pawley's Is.			1(S)
10:22	Litchfield Bch.			2(S)
10:25	Garden City			1
10:30	S. Myrtle Bch.			3(S)
10:31	Myrtle Bch.			4(S)
<b>Totals:</b>		<b>11</b>	<b>5</b>	<b>11</b>

**No. 7**  
**March 17, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
	Bulls Bay			1(w/shrimper)
	Murphy Is.			1
	Cape Is.			1
	Raccoon Key			1
	Debordieu Bch.	1	1	
	South Is.	2	1	
	Cedar Is.	2	1	
	Cape Is.	2	1	
	Cape Is.	1	1	
	Bull Is.			4
	Bulls Bay			2
	Bulls Bay			1
<b>Totals:</b>		<b>8</b>	<b>5</b>	<b>11</b>

**No. 8**  
**March 24, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
10:29	Bull Is.			2
10:34	Bull Is. north			2
10:38	Bull Is.	1	0	1 (S near net)
10:40	Bull Is. south			1
<b>Totals:</b>		<b>1</b>	<b>0</b>	<b>6</b>

**No. 9**  
**March 31, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
	Bull Is.			1
	Litchfield Bch.			7
	Huntington Bch.			1
	Cape Is.	3	1	
<b>Totals:</b>		<b>3</b>	<b>1</b>	<b>9</b>

**No. 10**  
**April 7, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
10:04	North Is.			3(N)
10:10	South Is.			1(N)
<b>Totals:</b>		<b>0</b>	<b>0</b>	<b>4</b>

**No. 11**  
**April 14, 1994**

<b>Time</b>	<b>Location</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
9:31	Cape Is.			1 (offshore)
	North Is.			2 (offshore)
	Litchfield Bch.			2 (offshore)
	Debordieu Bch.			1 (offshore)
	North Is.			2 (offshore)
	Murphy/Cedar			1
	North Is.			6
	Debordieu Bch.			1
<b>Totals:</b>		<b>0</b>	<b>0</b>	<b>16</b>

APPENDIX C

Year 2 Aerial Surveys in Area of Shad Fishery Effort:  
Dolphin/Net Observations

**No. 1****JANUARY 27, 1995 (Preliminary Flight):**

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
9:54	South Is.	33° 09.1	79° 09.7			1
10:00	Debidue Beach	33° 20.8	79° 07.6			1
10:06	Murrell's Inlet	33° 31.3	79° 01.9			1
10:20	Sand Is.	32° 12.1	79° 11.0			1
<b>Totals:</b>				<b>0</b>	<b>0</b>	<b>4</b>

**No. 2****FEBRUARY 1, 1995:**

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
10:55	Debidue Beach	33° 21.0	79° 08.5	3	3	
11:42	Litchfield Beach	33° 26.9	79° 06.4			1
11:54	North Is.	33° 17.1	79° 09.9	7	3	
12:03	South Is.	33° 08.7	79° 13.1	1	1	
12:14	Cape Is.	33° 02.8	79° 20.6	2	1	
<b>Totals:</b>				<b>13</b>	<b>8</b>	<b>1</b>

No. 3

FEBRUARY 7, 1995:

Time	Location	Latitude	Longitude	# Nets	# Boats	# Dolphins
9:50	Pawley's Is.	33° 22.1	79° 07.5			1 (offshore)
10:38	Debidue Beach	33° 24.7	79° 09.6	1	1	
10:39	Debidue Beach	33° 23.8	79° 08.3	1	1	
10:40	North Is.	33° 23.8	79° 08.3			1
10:40	North Is.	33° 22.6	79° 08.4			1
10:42	North Is.	33° 20.3	79° 08.5	1	2	
10:45	North Is.	33° 17.8	79° 10.1	1	1	
10:45	North Is.	33° 16.4	79° 09.6	1	0	
10:45	North Is.	33° 15.8	79° 10.1	1	0	
10:50	South Is.	33° 08.8	79° 13.6	1	0	
10:52	Cedar Is.	33° 08.0	79° 15.0	1	0	
10:55	Murphy Is.	33° 07.2	79° 16.6			2
10:55	Murphy Is.	33° 04.0	79° 20.2			2
11:03	Cape Is.	33° 02.1	79° 20.5	1	1	
11:04	Cape Is.	33° 02.0	79° 21.0	1	1	
<b>Totals:</b>				<b>10</b>	<b>7</b>	<b>7</b>

No. 4

FEBRUARY 14, 1995:

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
11:26	Garden City Bch	33° 32.6	79° 01.3	1	1	
11:34	Pawley's Is.	33° 23.3	79° 08.5	1	1	
11:34	Debidue Beach	33° 22.2	79° 08.7	1	1	
11:35	Debidue Beach	33° 21.4	79° 08.9	1	1	
11:35	Debidue Beach	33° 21.0	79° 09.2	1	1	
11:36	Debidue Beach	33° 20.0	79° 08.8	1	1	
11:50	South Island	33° 09.6	79° 12.4	2	1	
12:00	Cape Is.	33° 02.9	79° 20.1	1	1	
12:00	Cape Romain	33° 02.6	79° 20.5	2	1	
<b>Totals:</b>				<b>11</b>	<b>9</b>	<b>0</b>

No. 5

FEBRUARY 21, 1995:

Time	Location	Latitude	Longitude	# Nets	# Boats	# Dolphins
10:40	North Island	33° 14.0	79° 10.0			3 (offshore)
12:01	Garden City Bch	33° 32.1	79° 01.5	1	1	
12:08	Pawley's Is.	33° 24.8	79° 07.7	1	1	
12:11	Pawley's Is.	33° 23.0	79° 08.3	1	1	
12:11	Pawley's Is.	33° 22.2	79° 08.5	2	1	
12:11	Pawley's Is.	33° 22.4	79° 07.7	1	1	
12:15	Debidue Beach	33° 20.4	79° 08.6	1	1	
12:18	North Is.	33° 18.5	79° 09.6			1
12:19	North Is.	33° 17.6	79° 10.1	1	0	
12:20	North Is.	33° 16.5	79° 10.5	1	1	
12:21	North Is.	33° 15.1	79° 10.8	1	0	
12:43	South Is.	33° 10.1	79° 11.9	1	1	
12:45	South Is.	33° 08.9	79° 12.2	1	1	
12:46	South Is.	33° 09.0	79° 13.3	1	0	
12:53	Cape Is.	33° 03.2	79° 20.4	1	1	
12:54	Cape Is.	33° 02.9	79° 20.5	1	0	
12:55	Cape Is.	33° 02.4	79° 20.7	1	0	
12:55	Cape Is.	33° 01.8	79° 22.0	1	1	
12:56	Cape Is.	33° 01.0	79° 21.2	1	1	
<b>Totals:</b>				<b>18</b>	<b>12</b>	<b>4</b>

**No. 6**  
**MARCH 3, 1995:**

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
11:44	Pawley's Is.	33° 23.7	79° 07.5	1	1	
11:46	Debidue Beach	33° 22.4	79° 08.8	1	1	
11:47	Debidue Beach	33° 21.4	79° 09.0	1	1	
11:48	Debidue Beach	33° 20.4	79° 09.3	1	1	
12:15	South Is.	33° 09.3	79° 12.3	2	1	
12:27	Cape Is.	33° 02.3	79° 20.3	1	1	
12:30	Cape Is.	33° 03.2	79° 19.7	1	1	
12:32	Cape Is.	33° 00.7	79° 21.0	1	1	
<b>Totals:</b>				<b>9</b>	<b>8</b>	<b>0</b>

**No. 7**  
**MARCH 7, 1995:**

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
10:38	North Is.	32° 13.8	79° 09.5			1(offshore)
10:44	Debidue Beach	32° 22.8	79° 07.6			3(offshore)
11:53	Garden City Bch	33° 33.3	79° 00.7	1	1	
12:03	Debidue Beach	33° 23.0	79° 08.7	2	1	
12:44	Cape Is.	33° 03.9	79° 19.6	1	1	
12:45	Cape Is.	33° 04.6	79° 19.8	1	0	
12:50	Cape Is.	33° 02.8	79° 20.6	1	1	
12:51	Cape Is.	33° 02.0	79° 21.0	1	0	
<b>Totals:</b>				<b>7</b>	<b>4</b>	<b>4</b>

No. 8  
MARCH 14, 1995:

Time	Location	Latitude	Longitude	# Nets	# Boats	# Dolphins
10:50	Winyah Bay	33° 12.8	79° 09.2			2(offshore)
10:55	Debidue Beach	33° 21.9	79° 07.7			1(offshore)
10:57	Pawley's Is.	33° 25.5	79° 06.1			1(offshore)
	Pawley's Is.	33° 25.7	79° 07.2			1
	Debidue Beach	33° 22.6	78° 08.8	1	1	
	Debidue Beach	33° 20.3	79° 08.8	1	1	
	Debidue Beach	33° 21.1	78° 09.4	1	0	
12:22	North Is.	33° 18.2	78° 10.0	1	0	
	North Is.	33° 17.5	79° 10.1	1	0	
	North Is.	33° 17.1	79° 10.2	1	0	
	North Is.	33° 16.7	79° 10.1	1	0	
	North Is.	31° 51.8	78° 10.6	1	1	
	North Is.	33° 15.0	79° 10.7	1	0	
12:45	South Is.	33° 09.3	79° 12.5	1	1	
	South Is.	33° 08.9	79° 12.7	1	1	
	South Is.	33° 09.1	79° 13.0	1	1	
	Cape Is.	33° 04.0	79° 20.2	1	1	
	Cape Is.	33° 03.5	79° 20.3	1	0	
	Cape Is.	32° 02.8	79° 20.6	1	1	
	Cape Is.	33° 02.8	79° 20.8	1	0	
	Cape Is.	33° 01.8	79° 21.0	1	0	
	Cape Is.	33° 01.5	79° 21.3	1	1	
<b>Totals:</b>				<b>18</b>	<b>9</b>	<b>5</b>

No. 9

MARCH 21, 1995:

Time	Location	Latitude	Longitude	# Nets	# Boats	# Dolphins
11:49	Garden City Bch	33° 32.6	79° 01.2			1
11:54	Pawley's Is.	33° 23.9	79° 08.2			3
11:59	Pawley's Is.	33° 23.3	79° 08.6			1 (dead)
12:00	Debidue Beach	33° 21.5	79° 08.4	1	1	
12:04	North Is.	33° 16.0	79° 10.5	1	1	
12:04	North Is.	33° 14.7	79° 10.8	1	0	
12:26	South Is.	33° 09.2	79° 13.2	1	1	
12:37	Cape Is.	33° 03.7	79° 20.3	1	2	
12:38	Cape Is.	33° 02.5	79° 20.8	1	0	
<b>Totals:</b>				<b>6</b>	<b>5</b>	<b>5</b>

**No. 10**  
**MARCH 28, 1995:**

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
10:28	Pawley's Is.	33° 23.6	79° 06.8			4 (offshore)
10:30	Pawley's Is.	33° 25.0	79° 05.8			2 (offshore)
11:43	Garden City Bch	33° 33.5	79° 00.7			2
11:52	Pawley's Is.	33° 24.0	79° 08.0			2
11:54	Debidue Beach	33° 20.0	79° 09.2	1	1	
12:24	South Is.	33° 08.8	79° 12.5	1	2	
12:25	South Is.	33° 09.1	79° 13.2	1	0	
12:35	Cape Is.	33° 01.7	79° 20.7	1	1	
12:36	Cape Is.	33° 01.2	79° 21.0	1	1	
12:37	Cape Is.	33° 00.8	79° 21.3	1	0	
12:40	Cape Is.	32° 59.6	79° 21.1	1	1	
<b>Totals:</b>				<b>7</b>	<b>6</b>	<b>10</b>

**No. 11**  
**APRIL 4, 1995:**

<b>Time</b>	<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b># Nets</b>	<b># Boats</b>	<b># Dolphins</b>
11:55	North Is.	33° 17.9	79° 10.1	1	1	
11:56	North Is.	33° 15.3	79° 10.5	1	0	
12:35	Cape Is.	33° 03.5	79° 20.3	1	1	
12:36	Cape Is.	33° 03.4	79° 19.7	1	0	
12:37	Cape Is.	33° 02.6	79° 20.0	1	1	
12:37	Cape Is.	33° 02.9	79° 20.1	1	0	
<b>Totals:</b>				<b>6</b>	<b>3</b>	<b>0</b>

APPENDIX D

Net/Boat Observations During Aerial Surveys

**YEAR 1**

**FEBRUARY 3, 1994**

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	1	10.0	14.0
North Is	1	1	10.0	14.0
South Is	3	2	30.0	29.0
Cape Is	4	2	40.0	29.0
Raccoon Key	1	1	10.0	14.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
<b>TOTAL</b>	<b>10</b>	<b>7</b>		

**FEBRUARY 15, 1994**

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	1	8.0	20.0
North Is	0	0	0.0	0.0
South Is	3	1	23.0	20.0
Cape Is	6	2	46.0	40.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Sand Is.	1	0	8.0	0.0
Cedar Is	2	1	15.0	0.0
<b>TOTAL</b>	<b>13</b>	<b>5</b>		

FEBRUARY 28, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	0	0	0.0	0.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Sand Is.	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	0	0		

MARCH 8, 1994\*

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	NR	25.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	2	NR	50.0	0.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Sand Is.	0	0	0.0	0.0
Cedar Is	1	NR	25.0	0.0
TOTAL	4	0		

\* Not a scheduled flight. Recorded by SCWMRD on eagle survey.  
 NR = not recorded

MARCH 15, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	3	1	27.0	20.0
North Is	0	0	0.0	0.0
South Is	1	1	9.0	20.0
Cape Is	4	2	36.0	40.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Sand Is.	0	0	0.0	0.0
Cedar Is	3	1	27.0	20.0
TOTAL	11	5		

MARCH 17, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	1	13.0	20.0
North Is	0	0	0.0	0.0
South Is	2	1	25.0	20.0
Cape Is	3	2	38.0	40.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Sand Is.	0	0	0.0	0.0
Cedar Is	2	1	25.0	20.0
TOTAL	8	5		

MARCH 24, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	0	0	0.0	0.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Bull Is.	1	0	100.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	1	0		

MARCH 31, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	3	1	100.0	100.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Bull Is.	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	3	1		

APRIL 7, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	0	0	0.0	0.0
Raccoon Key	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Bull Is.	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	0	0		

APRIL 14, 1994

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	0	0	0.0	0.0
Raccoon Key	0	0	0.0	0.0
Garden City	0	0	0.0	0.0
Bull Is.	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	0	0		

**YEAR 2**

FEBRUARY 1, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	3	3	23.1	37.5
North Is	7	3	53.8	37.5
South Is	1	1	7.7	12.5
Cape Is	2	1	15.4	12.5
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
<b>TOTAL</b>	<b>13</b>	<b>8</b>		

FEBRUARY 7, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	2	2	20.0	28.6
North Is	4	3	40.0	42.9
South Is	1	0	10.0	0.0
Cape Is	2	2	20.0	28.6
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	1	0	10.0	0.0
<b>TOTAL</b>	<b>10</b>	<b>7</b>		

FEBRUARY 14, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	4	4	36.4	44.4
North Is	0	0	0.0	0.0
South Is	2	1	18.2	11.1
Cape Is	1	1	9.1	11.1
Pawleys Is	1	1	9.1	11.1
Garden City Bch	1	1	9.1	11.1
Cape Romain	2	1	18.2	11.1
Cedar Is	0	0	0.0	0.0
TOTAL	11	9		

FEBRUARY 21, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	1	5.6	8.3
North Is	3	1	16.7	8.3
South Is	3	2	16.7	16.7
Cape Is	5	3	27.8	25.0
Pawleys Is	5	4	27.8	33.3
Garden City Bch	1	1	5.6	8.3
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	18	12		

MARCH 3, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	3	3	33.3	8.3
North Is	0	0	0.0	8.3
South Is	2	1	22.2	16.7
Cape Is	3	3	33.3	25.0
Pawleys Is	1	1	11.1	33.3
Garden City Bch	0	0	0.0	8.3
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	9	8		

MARCH 7, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	2	1	28.6	8.3
North Is	0	0	0.0	8.3
South Is	0	0	0.0	16.7
Cape Is	4	2	57.1	25.0
Pawleys Is	0	0	0.0	33.3
Garden City Bch	1	1	14.3	8.3
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	7	4		

MARCH 14, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	3	2	16.7	22.2
North Is	6	1	33.3	11.1
South Is	3	3	16.7	33.3
Cape Is	6	3	33.3	33.3
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	18	9		

MARCH 21, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	1	16.7	20.0
North Is	2	1	33.3	20.0
South Is	1	1	16.7	20.0
Cape Is	2	2	33.3	40.0
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	6	5		

MARCH 28, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	1	1	14.3	16.7
North Is	0	0	0.0	0.0
South Is	2	2	28.6	33.3
Cape Is	4	3	57.1	50.0
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	7	6		

APRIL 4, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is.	2	1	33.3	33.3
South Is	0	0	0.0	0.0
Cape Is	4	2	66.7	66.7
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	6	3		

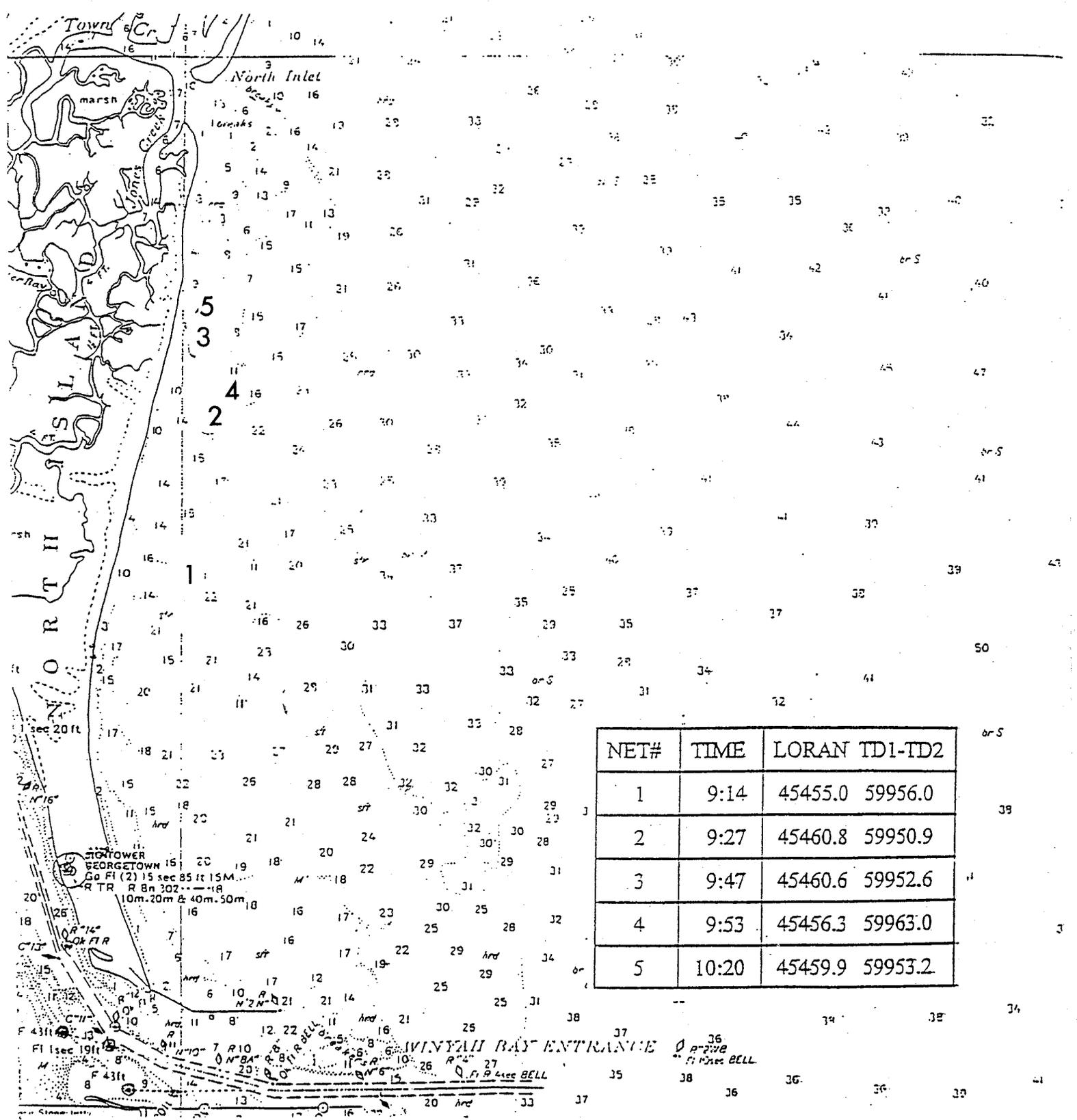
APRIL 12, 1995

Location	#Nets	#Boats	%Nets	% Boats
Debordieu Beach	0	0	0.0	0.0
North Is	0	0	0.0	0.0
South Is	0	0	0.0	0.0
Cape Is	0	0	0.0	0.0
Pawleys Is	0	0	0.0	0.0
Garden City Bch	0	0	0.0	0.0
Cape Romain	0	0	0.0	0.0
Cedar Is	0	0	0.0	0.0
TOTAL	0	0		

**APPENDIX E**

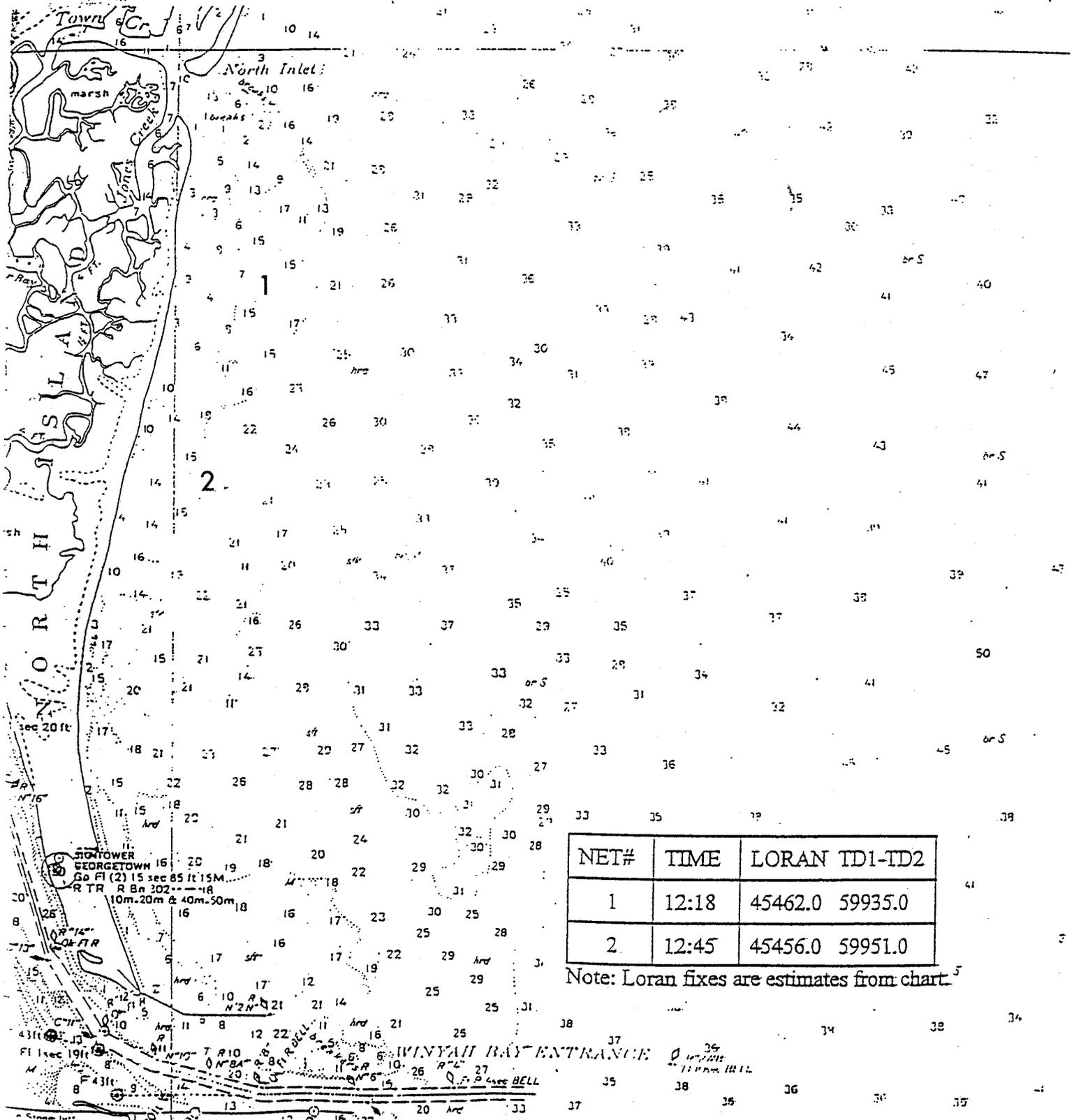
**Observed Ocean Shad Net Locations From Boat Surveys**

COLLECTION # 1 - FEBRUARY 14, 1995  
OBSERVED NET LOCATIONS

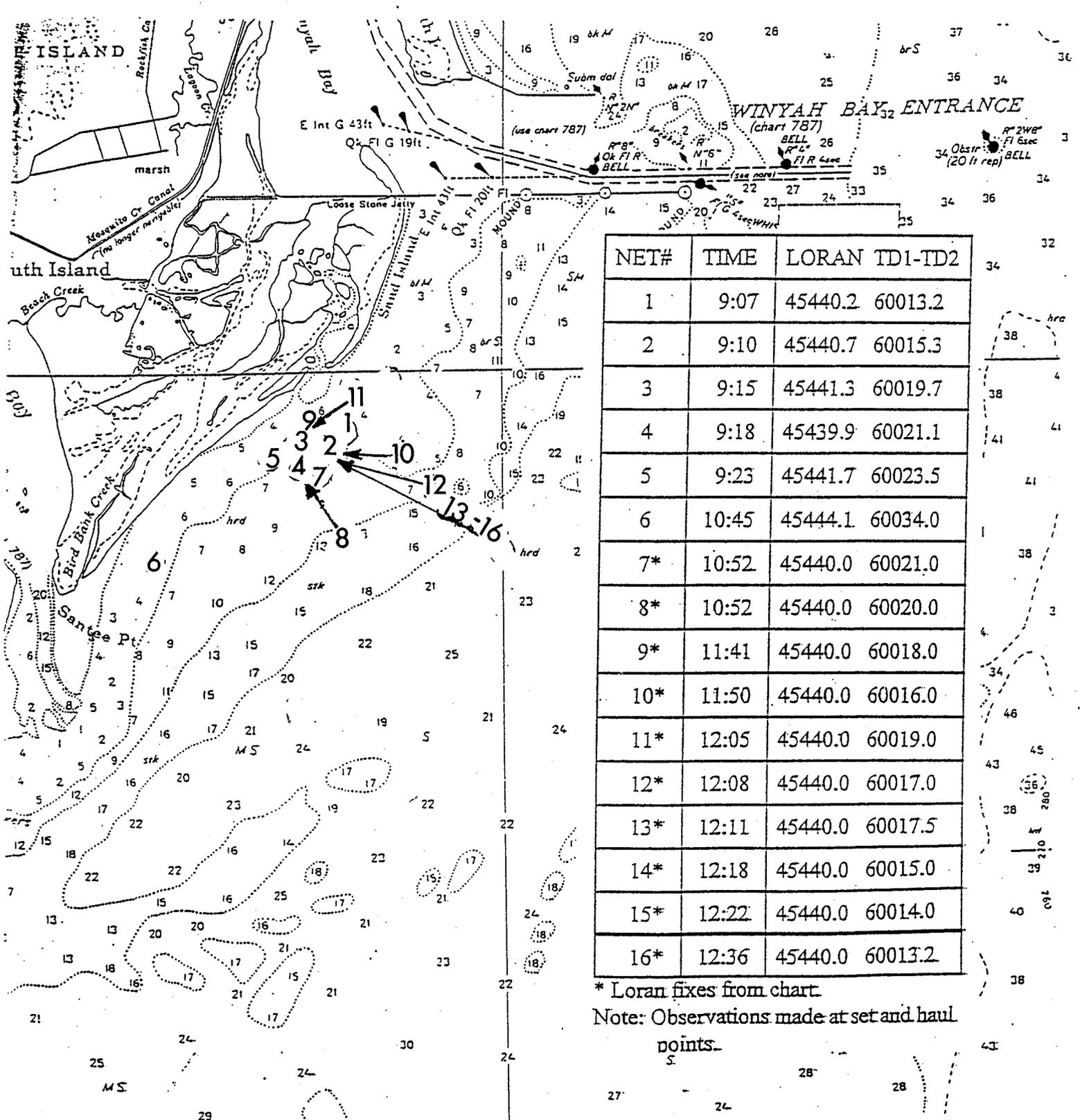


NET#	TIME	LORAN TD1-TD2
1	9:14	45455.0 59956.0
2	9:27	45460.8 59950.9
3	9:47	45460.6 59952.6
4	9:53	45456.3 59963.0
5	10:20	45459.9 59953.2

COLLECTION # 2 - FEBRUARY 16, 1995  
OBSERVED NET LOCATIONS



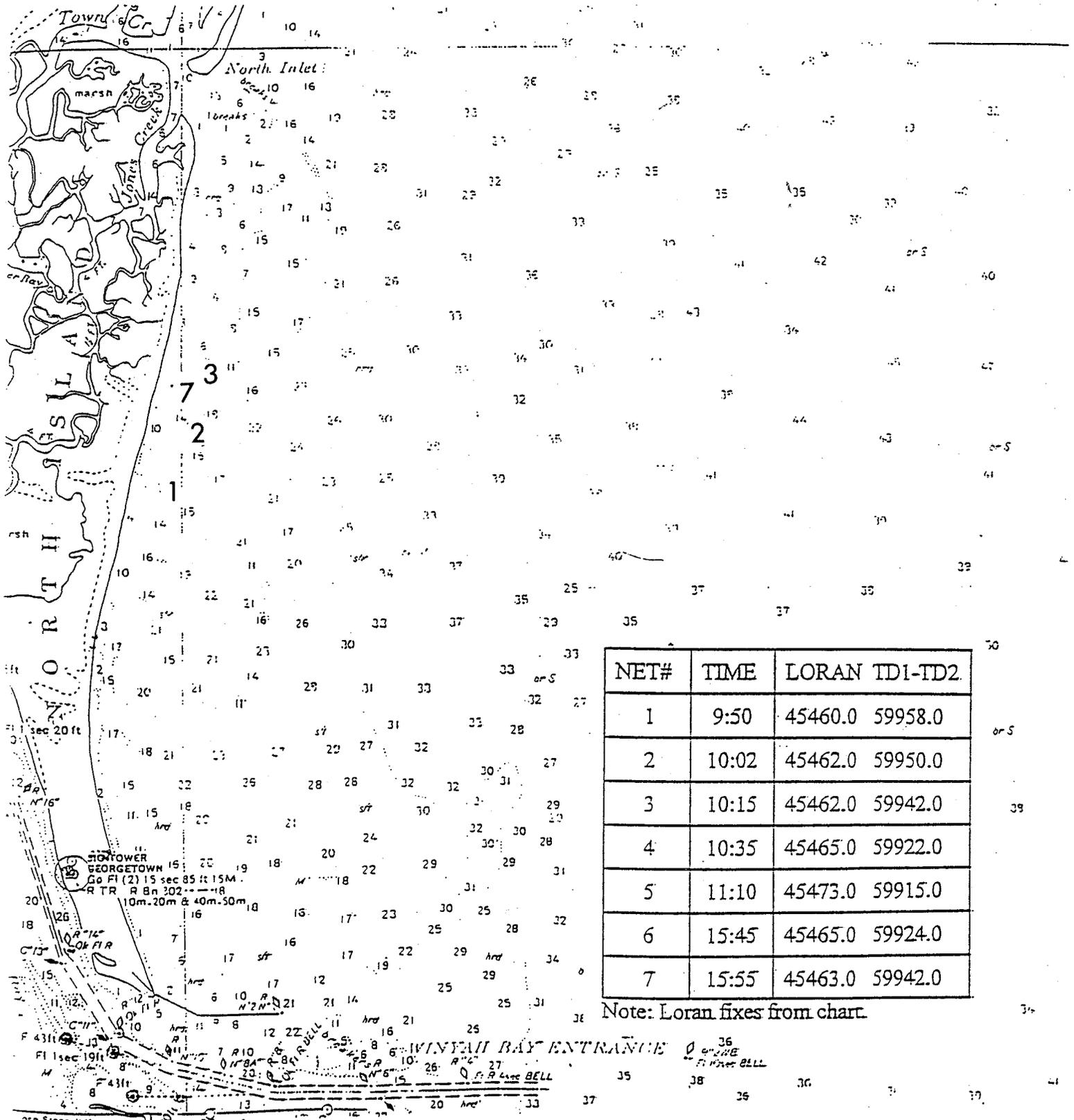
COLLECTION # 3 - FEBRUARY 21, 1995  
OBSERVED NET LOCATIONS



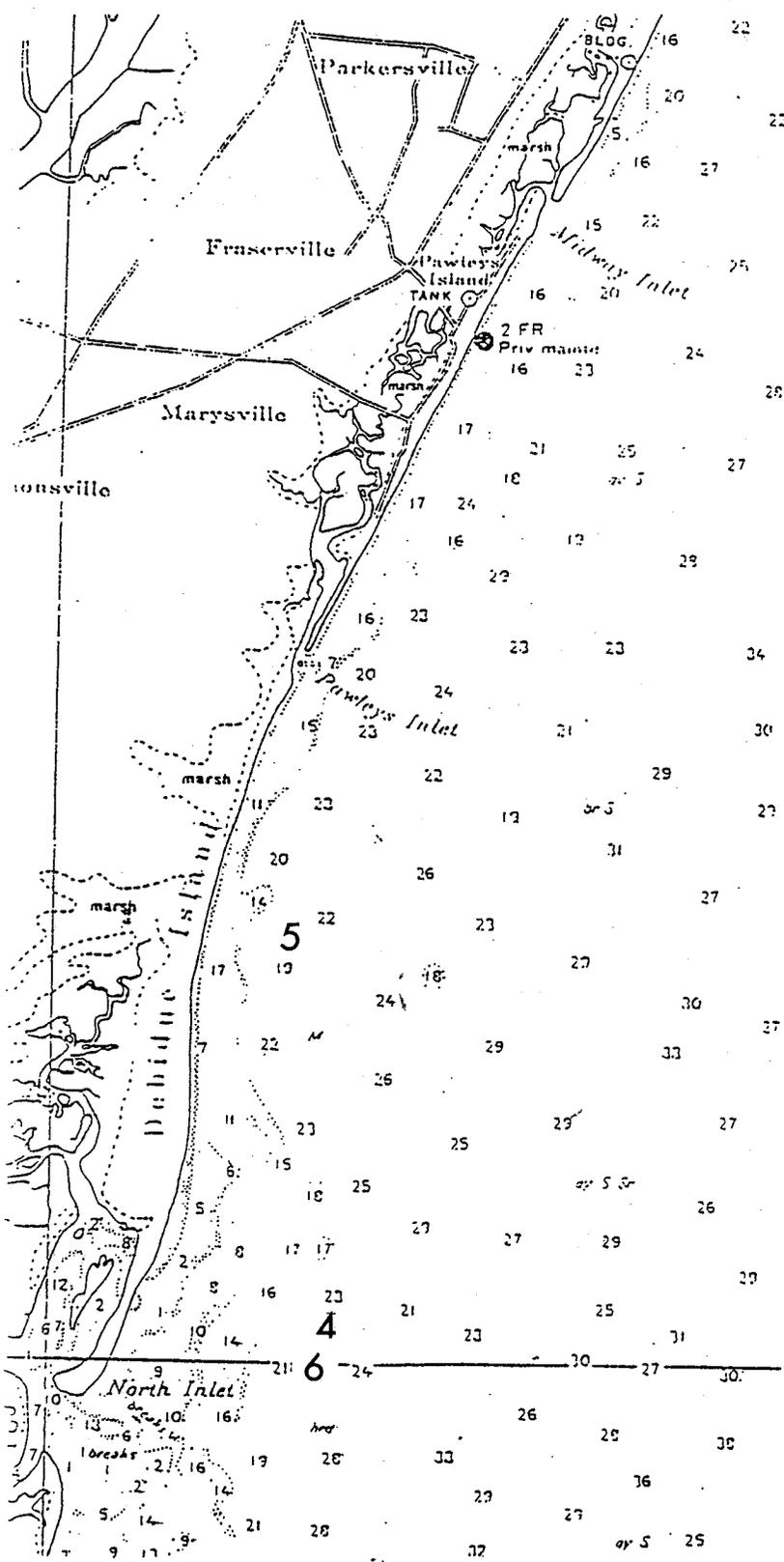
NET#	TIME	LORAN TD1-TD2
1	9:07	45440.2 60013.2
2	9:10	45440.7 60015.3
3	9:15	45441.3 60019.7
4	9:18	45439.9 60021.1
5	9:23	45441.7 60023.5
6	10:45	45444.1 60034.0
7*	10:52	45440.0 60021.0
8*	10:52	45440.0 60020.0
9*	11:41	45440.0 60018.0
10*	11:50	45440.0 60016.0
11*	12:05	45440.0 60019.0
12*	12:08	45440.0 60017.0
13*	12:11	45440.0 60017.5
14*	12:18	45440.0 60015.0
15*	12:22	45440.0 60014.0
16*	12:36	45440.0 60013.2

\* Loran fixes from chart.  
Note: Observations made at set and haul points.

COLLECTION # 4 - FEBRUARY 22, 1995  
OBSERVED NET LOCATIONS



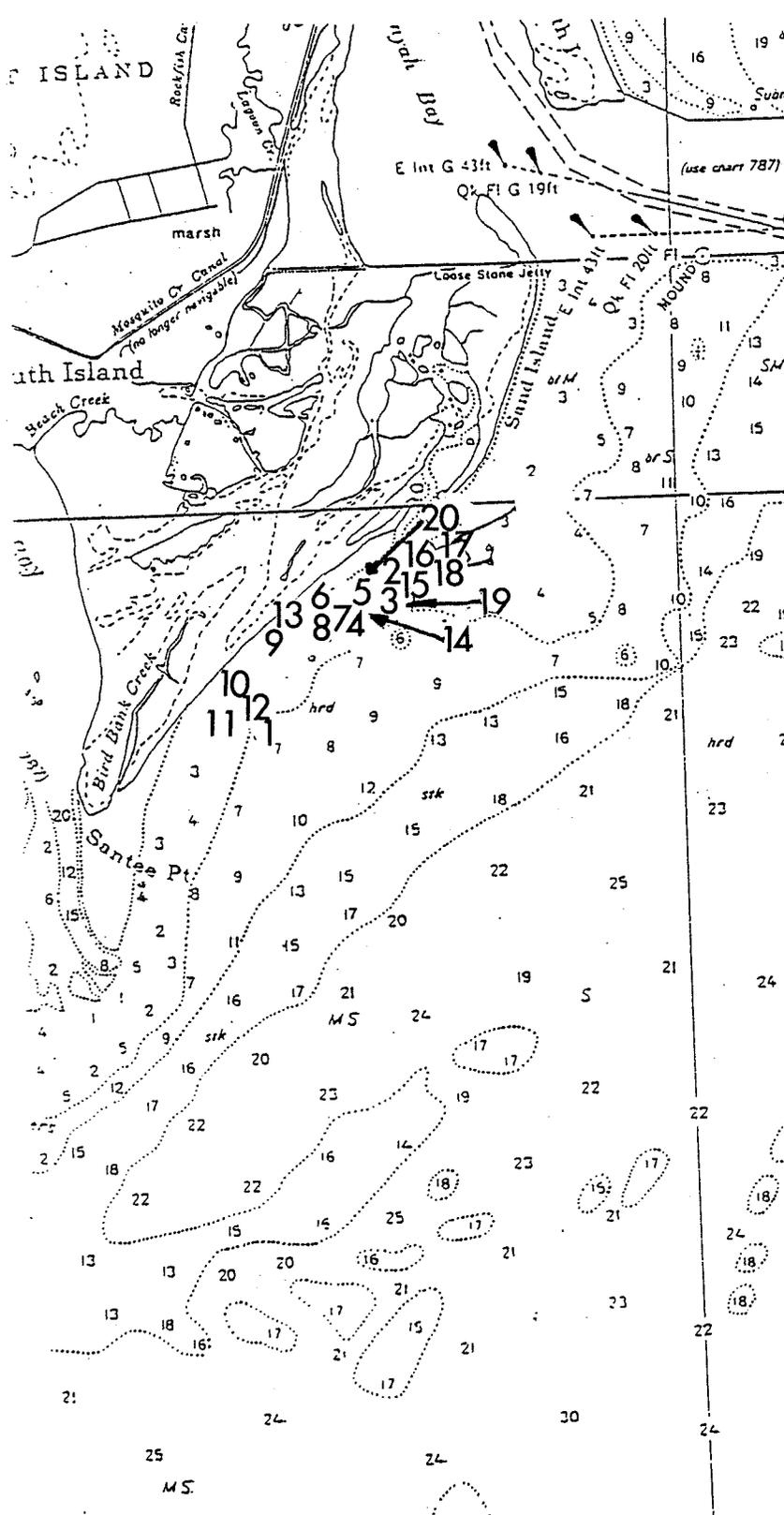
COLLECTION # 4 - FEBRUARY 22, 1995.  
OBSERVED NET LOCATIONS



NET#	TIME	LORAN TD1-TD2
1	9:50	45460.0 59958.0
2	10:02	45462.0 59950.0
3	10:15	45462.0 59942.0
4	10:35	45465.0 59922.0
5	11:10	45473.0 59915.0
6	15:45	45465.0 59924.0
7	15:55	45463.0 59942.0

Note: Loran fixes from chart.

COLLECTION # 5 - FEBRUARY 23, 1995  
OBSERVED NET LOCATIONS

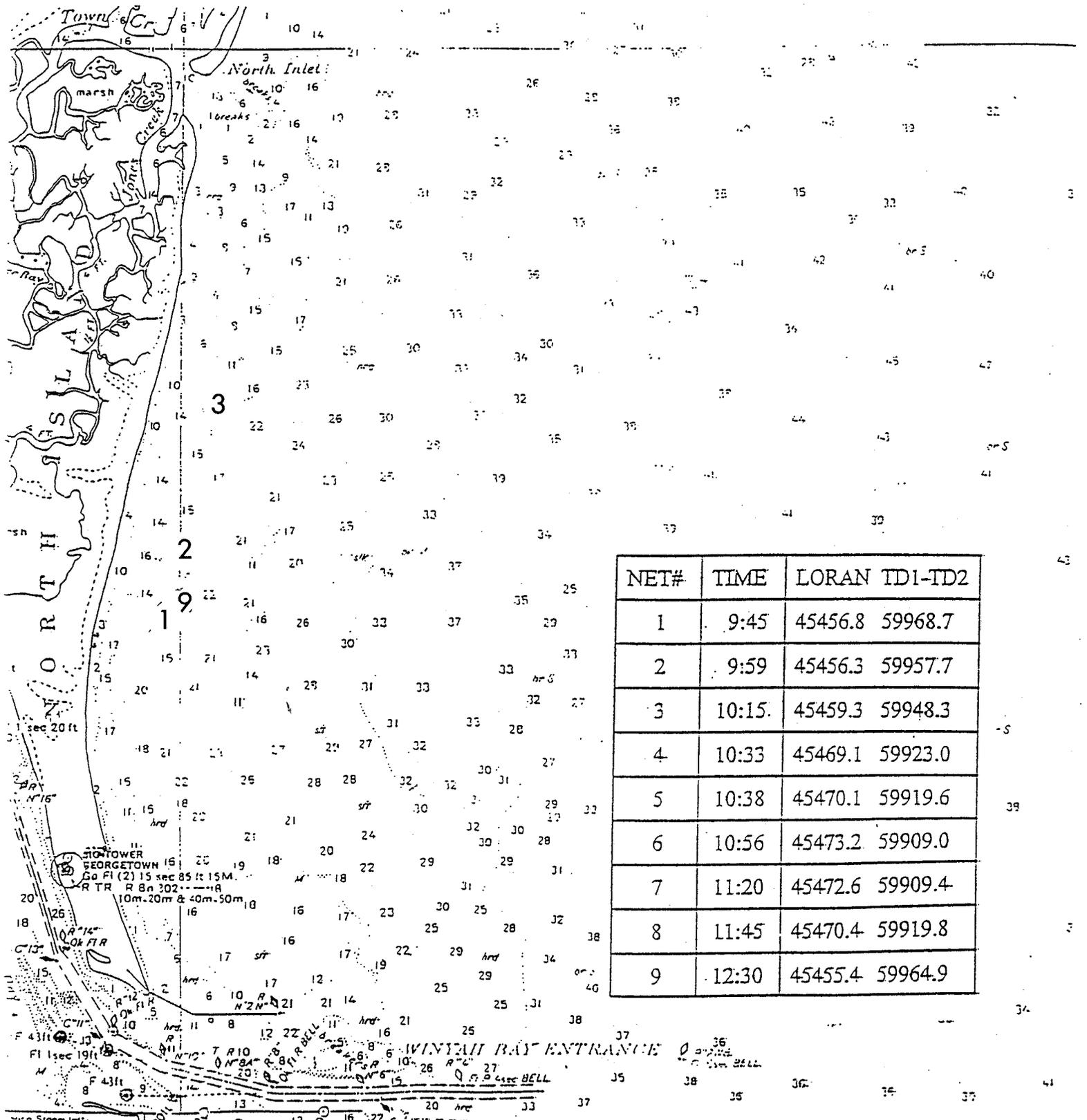


NET#	TIME	LORAN TD1-TD2
1	9:48	45441.2 60030.8
2	10:25	45440.8 60014.7
3	10:46	45440.3 60018.2
4	10:50	45441.8 60022.5
5	10:54	45441.4 60021.3
6	11:00	45442.7 60024.6
7	11:27	45441.6 60024.0
8	11:30	45441.8 60025.4
9	11:50	45442.9 60029.4
10	12:02	45442.5 60033.9
11	12:35	45442.0 60035.6
12	12:39	45442.9 60032.4
13	12:43	45442.9 60025.1
14	12:48	45442.5 60021.7
15	12:52	45442.0 60017.8
16	13:03	45441.6 60013.6
17	13:30	45441.6 60013.6
18	13:32	45440.5 60013.4
19	13:36	45440.9 60017.4
20	13:44	45441.6 60021.1

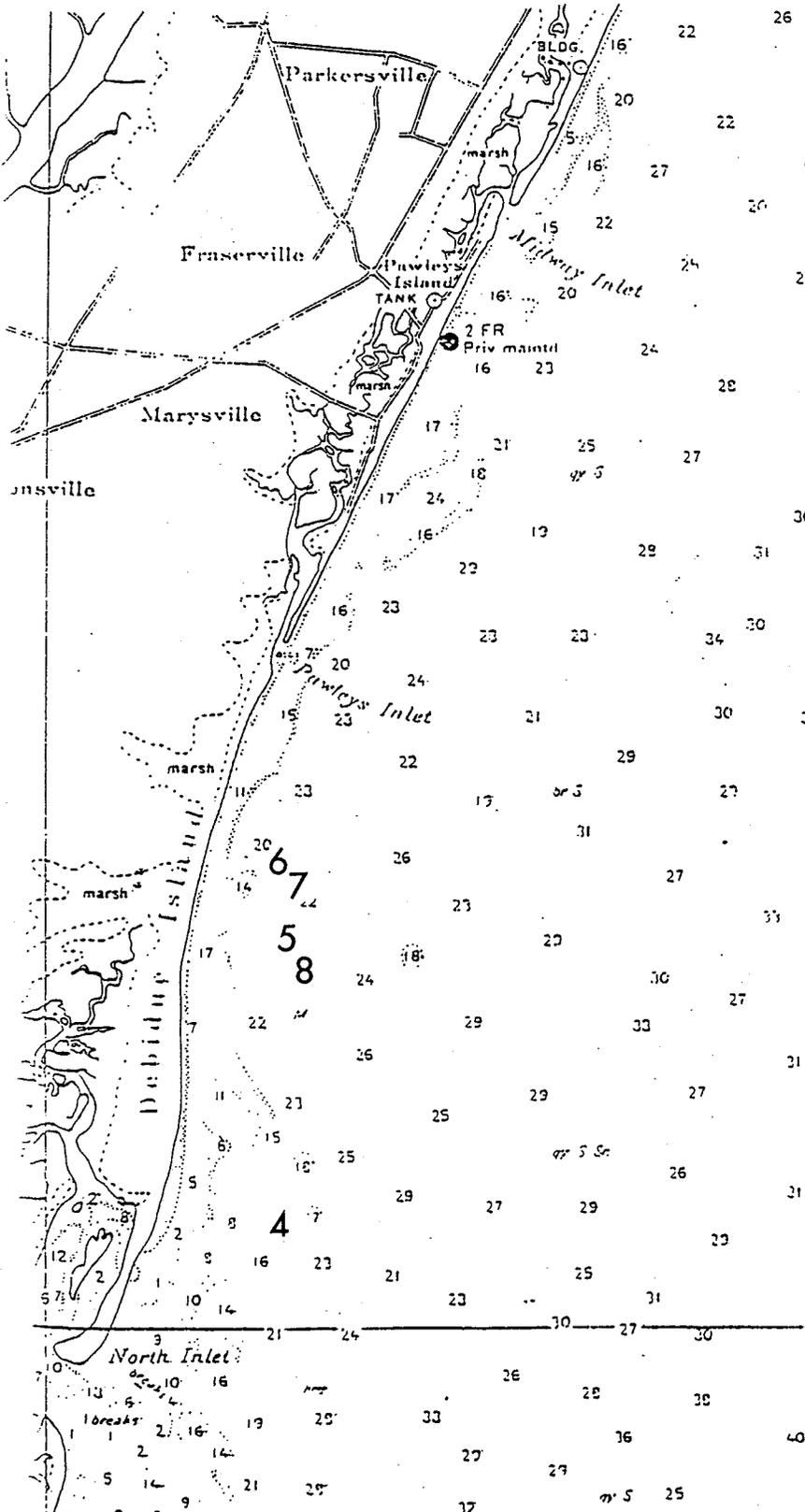
R 2WB  
Fl 6sec  
repj BELL

36 34 32 34 38 41 41 38 44 34 46 43 38 40 38 43 28 28 27 24

COLLECTION # 6 - FEBRUARY 28, 1995  
OBSERVED NET LOCATIONS

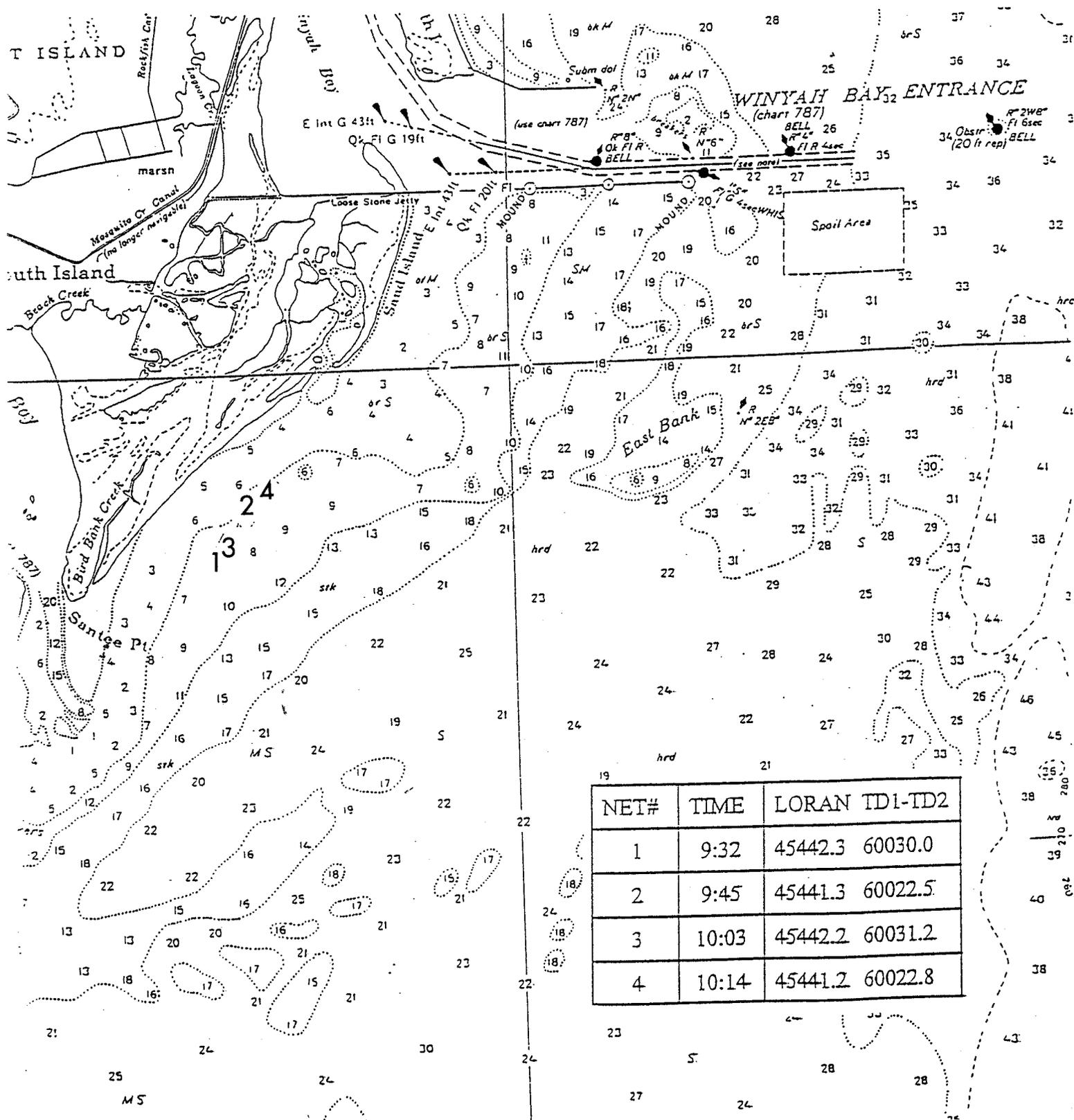


COLLECTION # 6 - FEBRUARY 28, 1995  
OBSERVED NET LOCATIONS



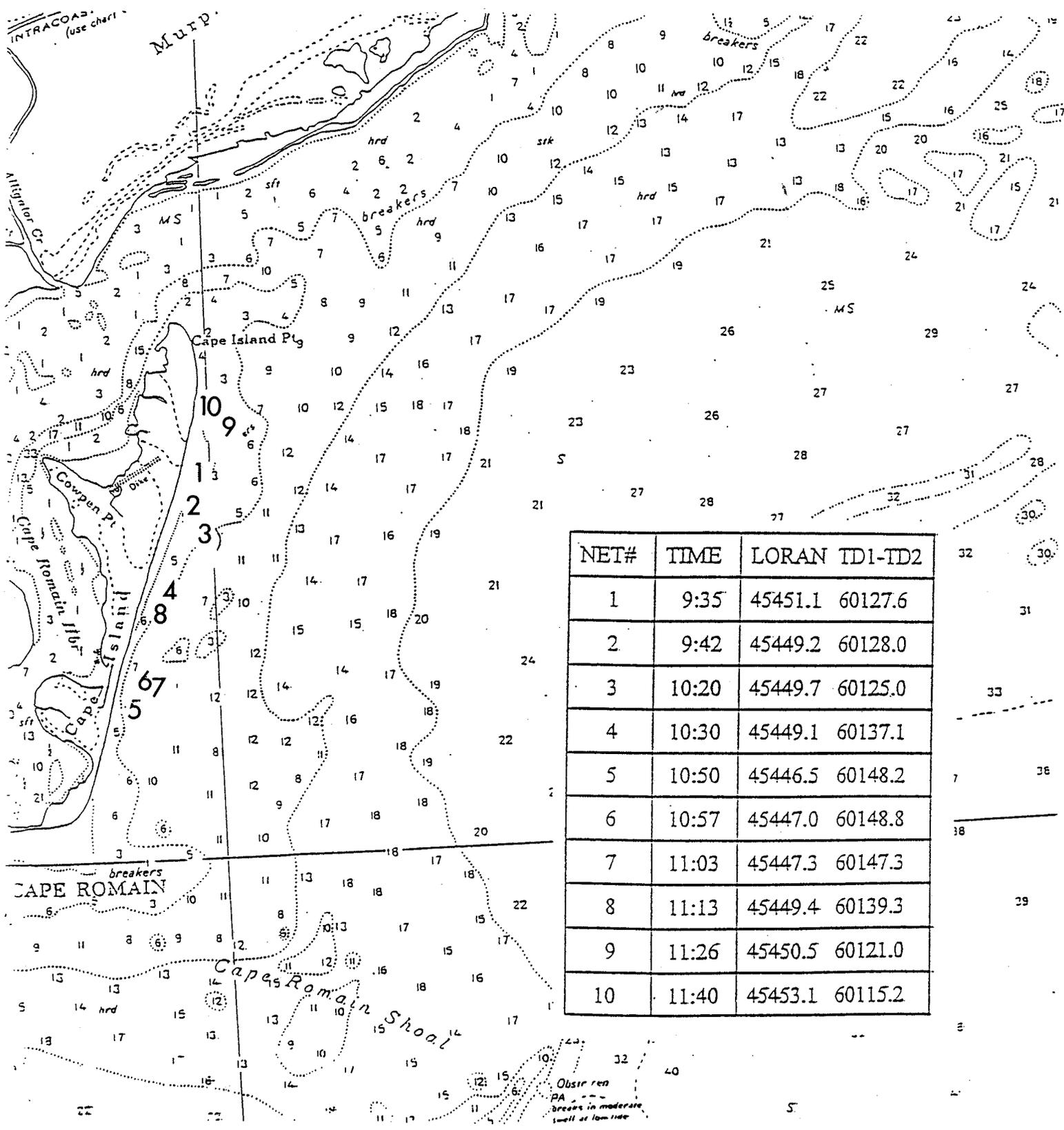
NET#	TIME	LORAN TD1-TD2
1	9:45	45456.8 59968.7
2	9:59	45456.3 59957.7
3	10:15	45459.3 59948.3
4	10:33	45469.1 59923.0
5	10:38	45470.1 59919.6
6	10:56	45473.2 59909.0
7	11:20	45472.6 59909.4
8	11:45	45470.4 59919.8
9	12:30	45455.4 59964.9

COLLECTION # 7 - MARCH 1, 1995  
OBSERVED NET LOCATIONS



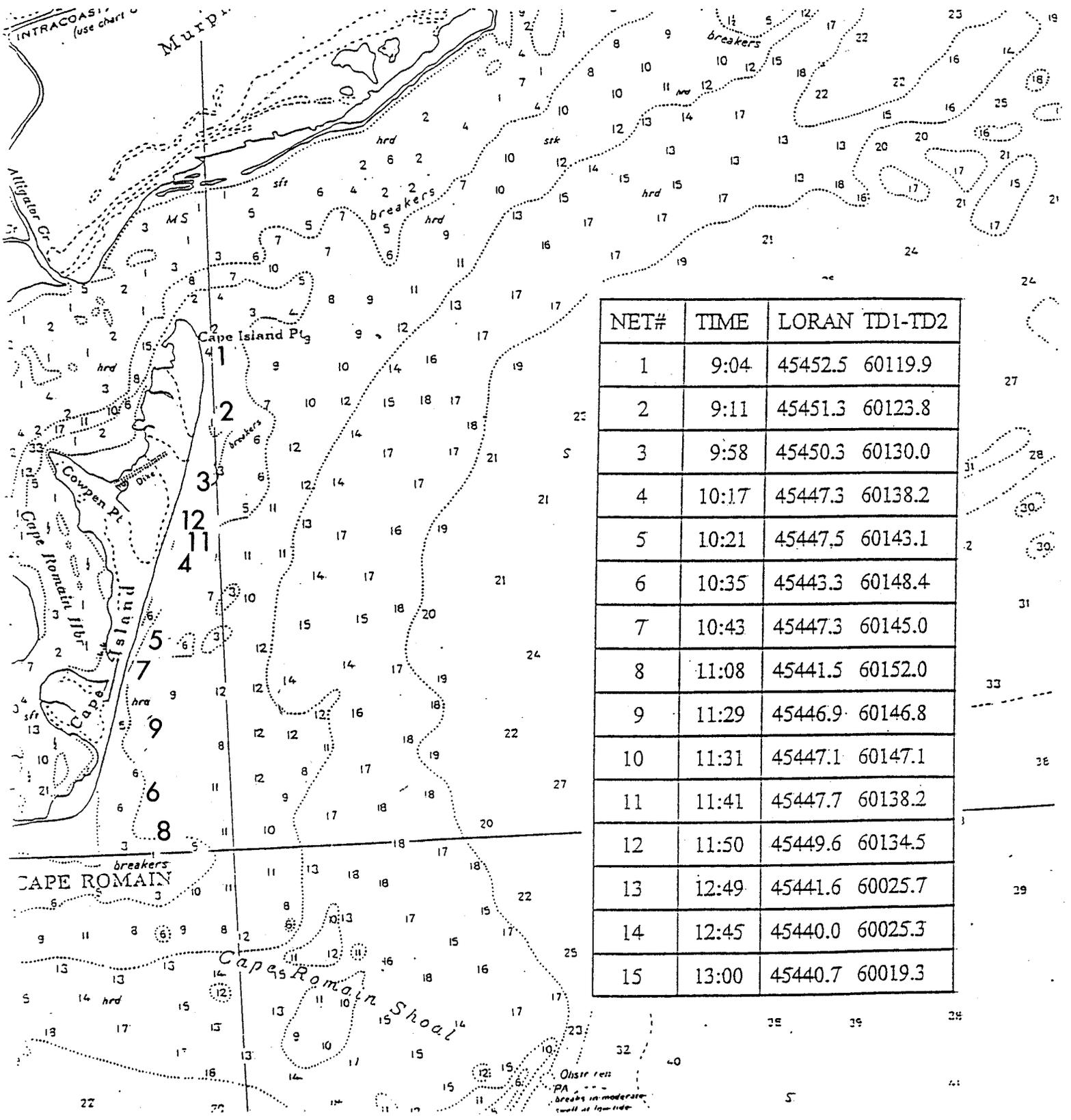
NET#	TIME	LORAN TD1-TD2
1	9:32	45442.3 60030.0
2	9:45	45441.3 60022.5
3	10:03	45442.2 60031.2
4	10:14	45441.2 60022.8

COLLECTION # 8 - MARCH 7, 1995  
OBSERVED NET LOCATIONS



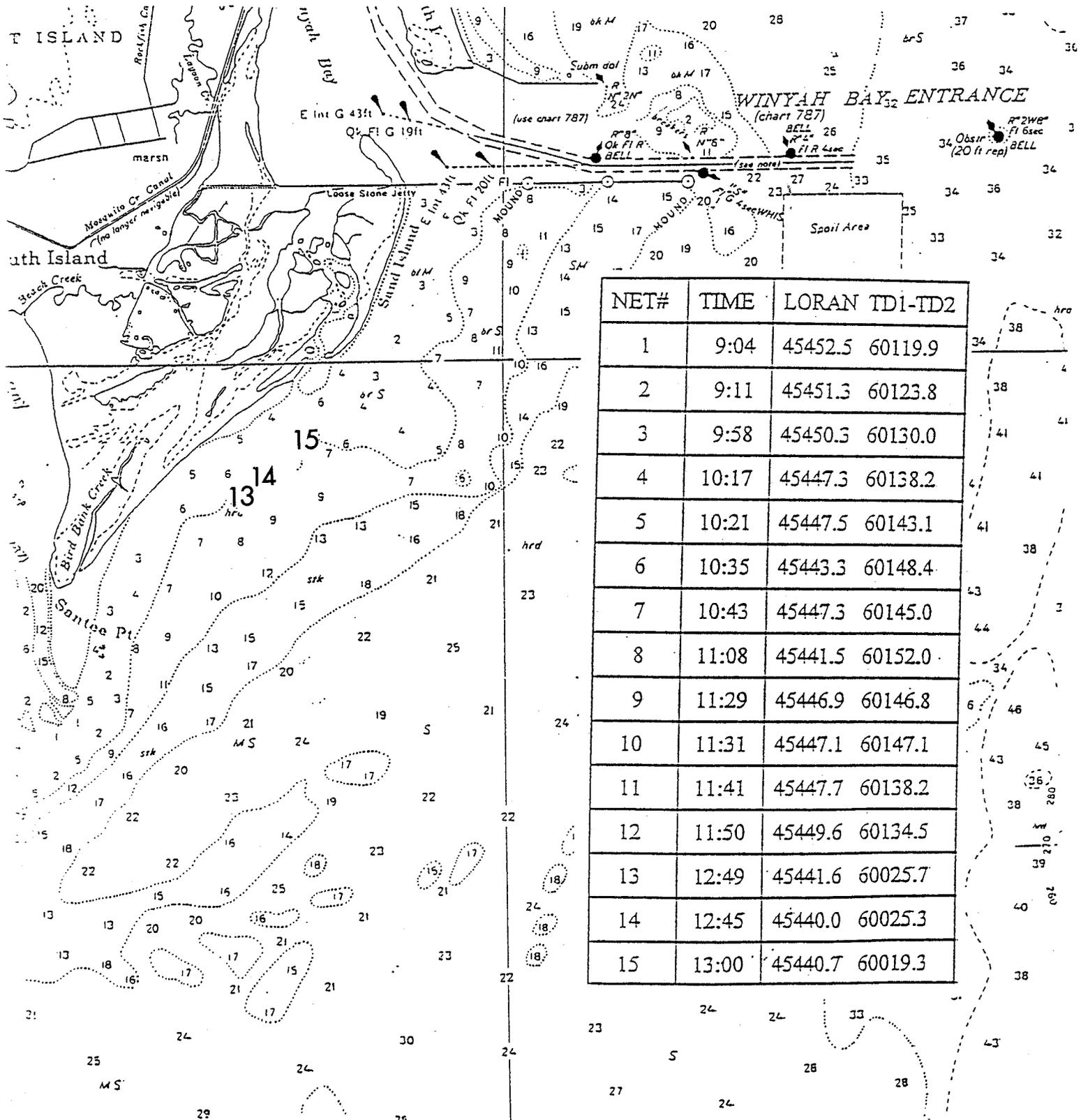
NET#	TIME	LORAN TD1-TD2
1	9:35	45451.1 60127.6
2	9:42	45449.2 60128.0
3	10:20	45449.7 60125.0
4	10:30	45449.1 60137.1
5	10:50	45446.5 60148.2
6	10:57	45447.0 60148.8
7	11:03	45447.3 60147.3
8	11:13	45449.4 60139.3
9	11:26	45450.5 60121.0
10	11:40	45453.1 60115.2

COLLECTION # 9 - MARCH 14, 1995  
OBSERVED NET LOCATIONS

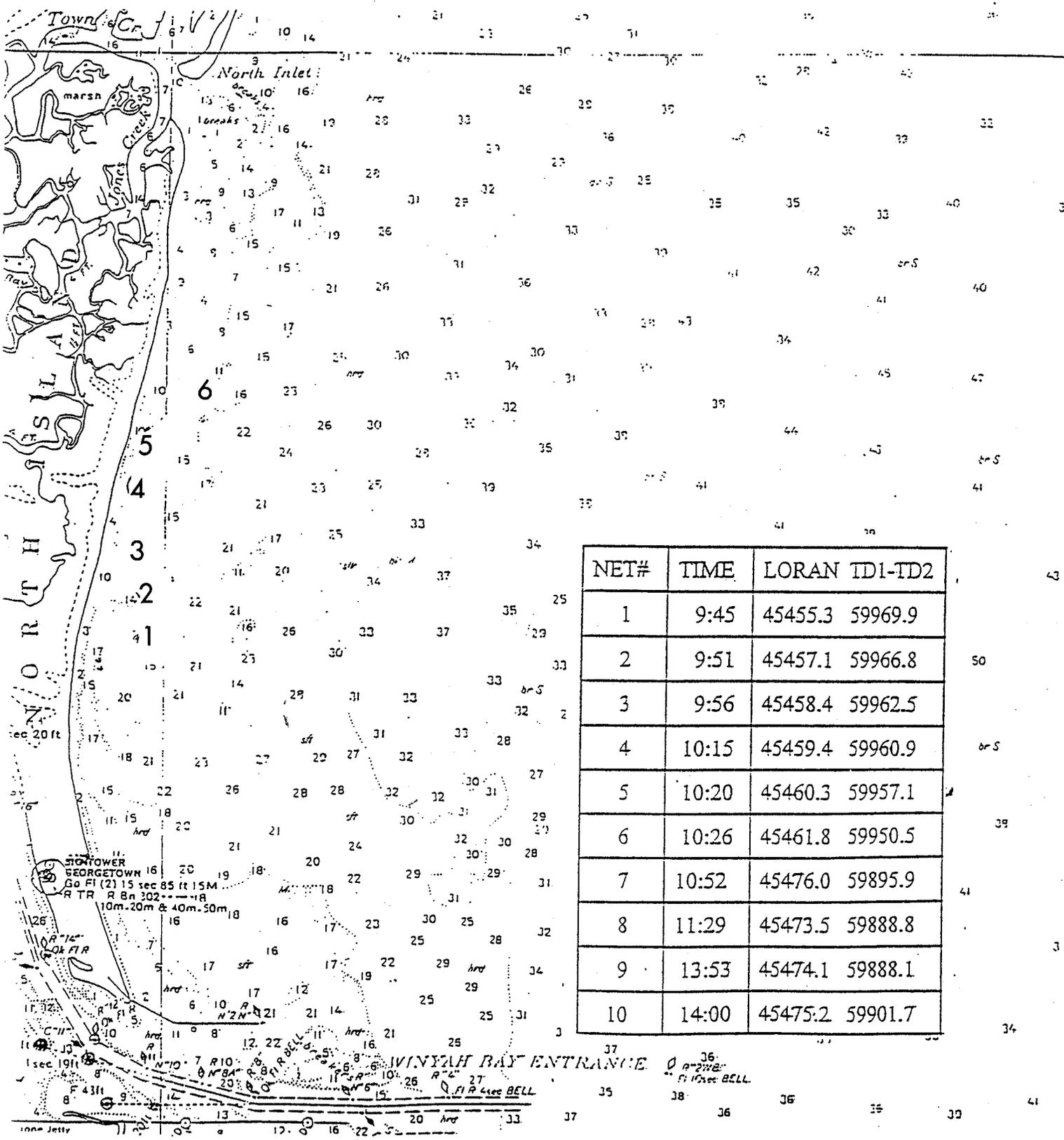


NET#	TIME	LORAN TD1-TD2
1	9:04	45452.5 60119.9
2	9:11	45451.3 60123.8
3	9:58	45450.3 60130.0
4	10:17	45447.3 60138.2
5	10:21	45447.5 60143.1
6	10:35	45443.3 60148.4
7	10:43	45447.3 60145.0
8	11:08	45441.5 60152.0
9	11:29	45446.9 60146.8
10	11:31	45447.1 60147.1
11	11:41	45447.7 60138.2
12	11:50	45449.6 60134.5
13	12:49	45441.6 60025.7
14	12:45	45440.0 60025.3
15	13:00	45440.7 60019.3

COLLECTION #9 - MARCH 14, 1995  
OBSERVED NET LOCATIONS

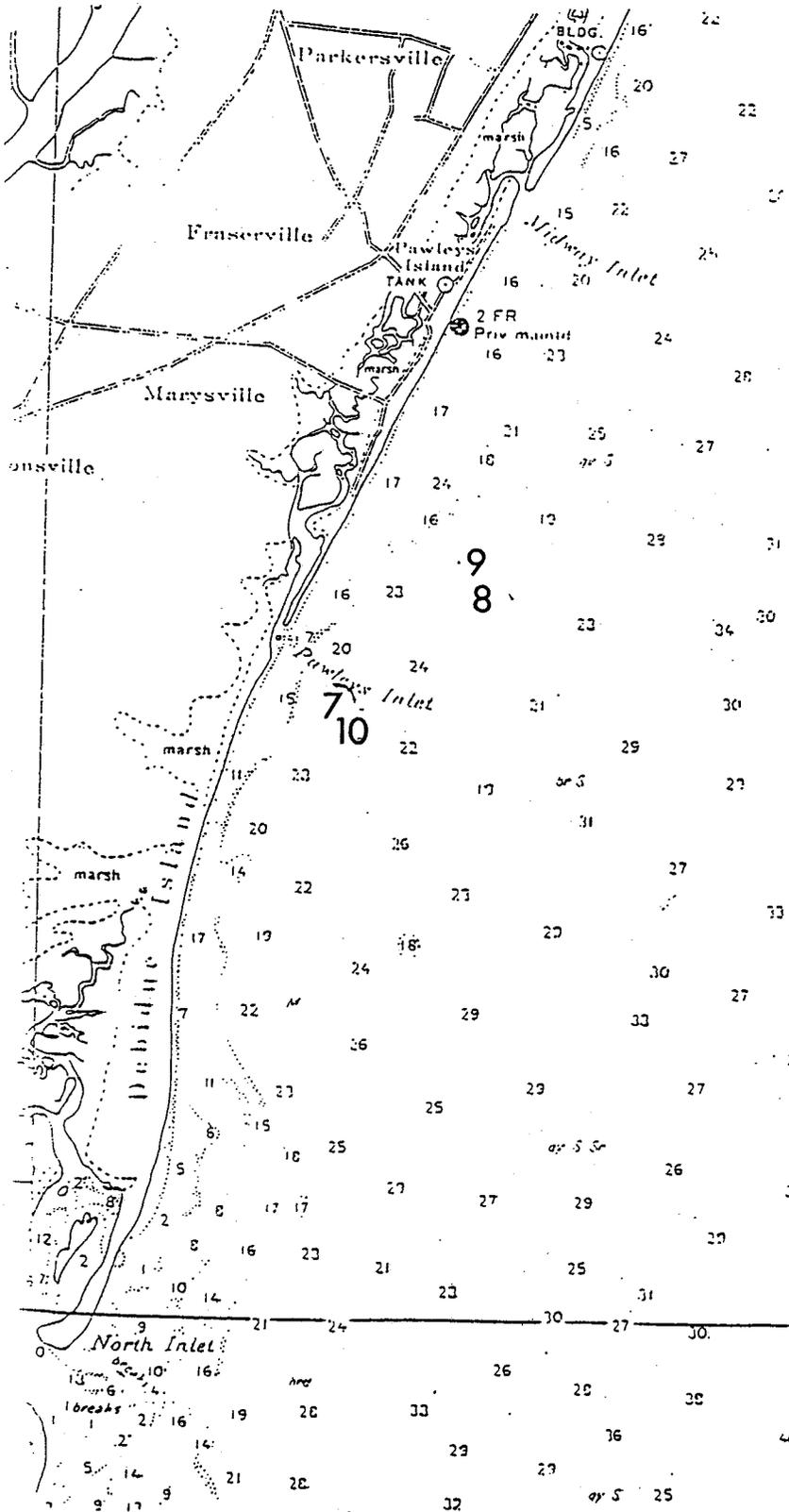


COLLECTION # 10 - MARCH 15, 1995  
OBSERVED NET LOCATIONS



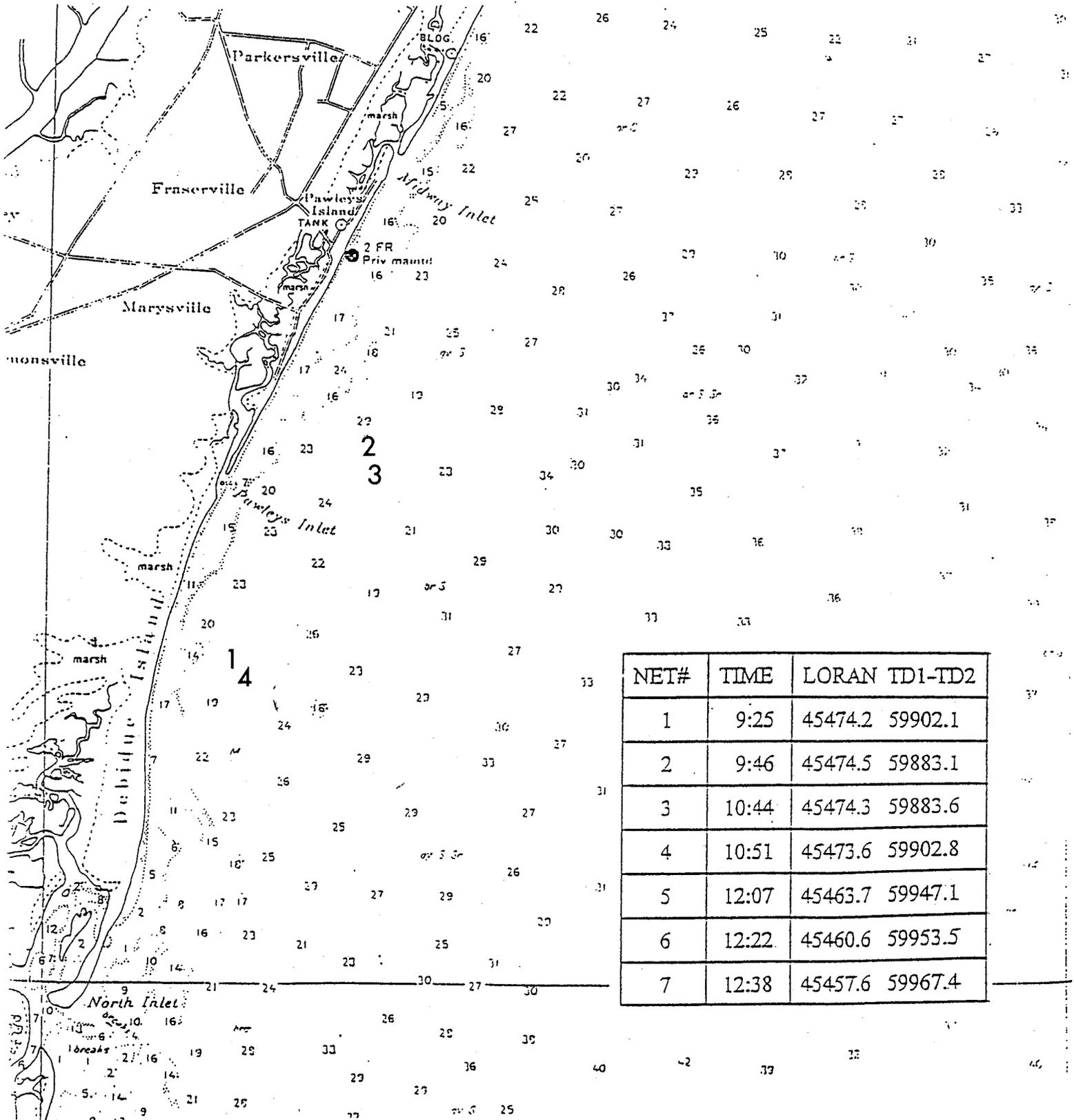
NET#	TIME	LORAN TD1-TD2
1	9:45	45455.3 59969.9
2	9:51	45457.1 59966.8
3	9:56	45458.4 59962.5
4	10:15	45459.4 59960.9
5	10:20	45460.3 59957.1
6	10:26	45461.8 59950.5
7	10:52	45476.0 59895.9
8	11:29	45473.5 59888.8
9	13:53	45474.1 59888.1
10	14:00	45475.2 59901.7

COLLECTION # 10 - MARCH 15, 1995  
OBSERVED NET LOCATIONS

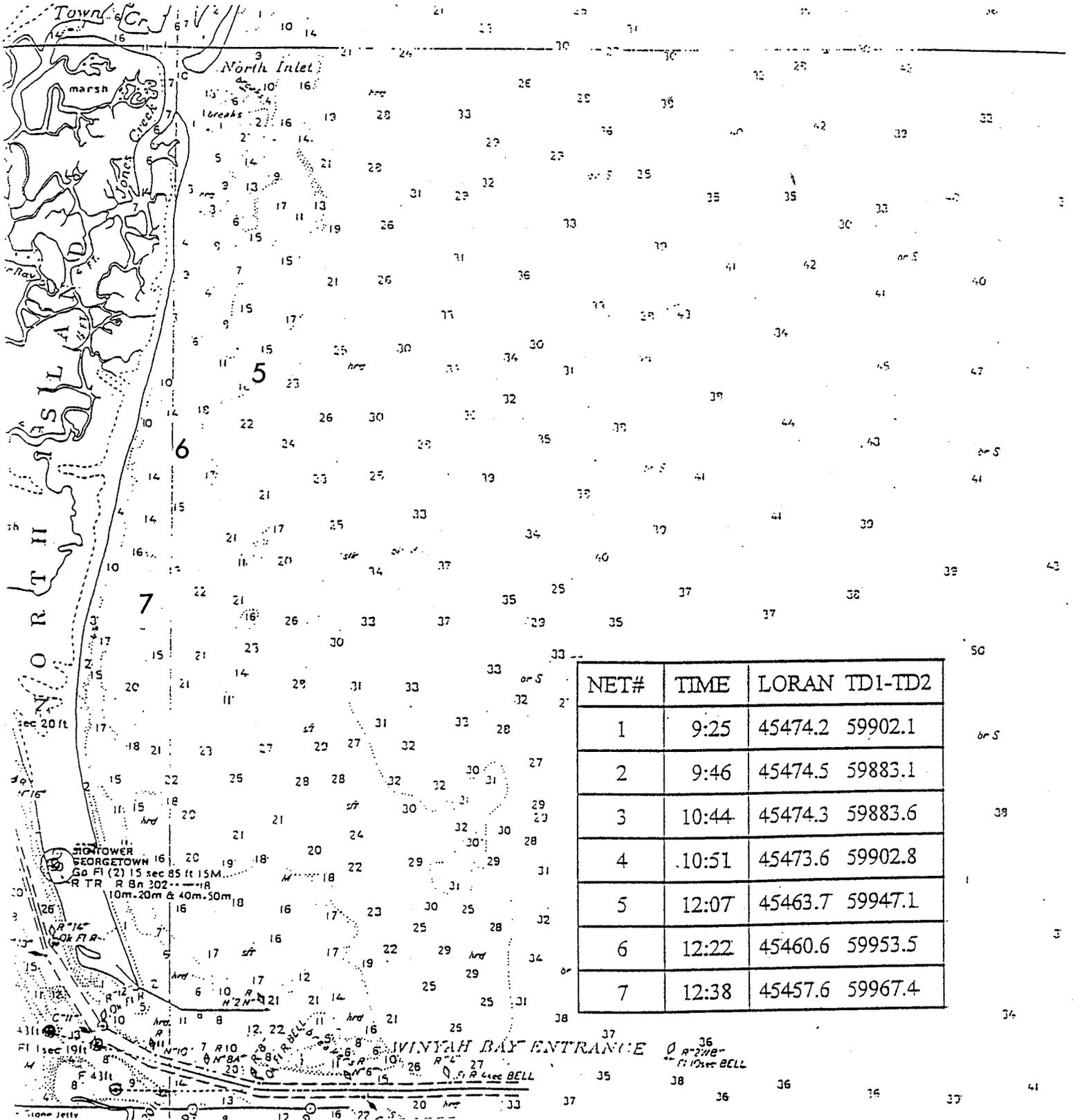


NET#	TIME	LORAN TD1-TD2
1	9:45	45455.3 59969.9
2	9:51	45457.1 59966.8
3	9:56	45458.4 59962.5
4	10:15	45459.4 59960.9
5	10:20	45460.3 59957.1
6	10:26	45461.8 59950.5
7	10:52	45476.0 59895.9
8	11:29	45473.5 59888.8
9	13:53	45474.1 59888.1
10	14:00	45475.2 59901.7

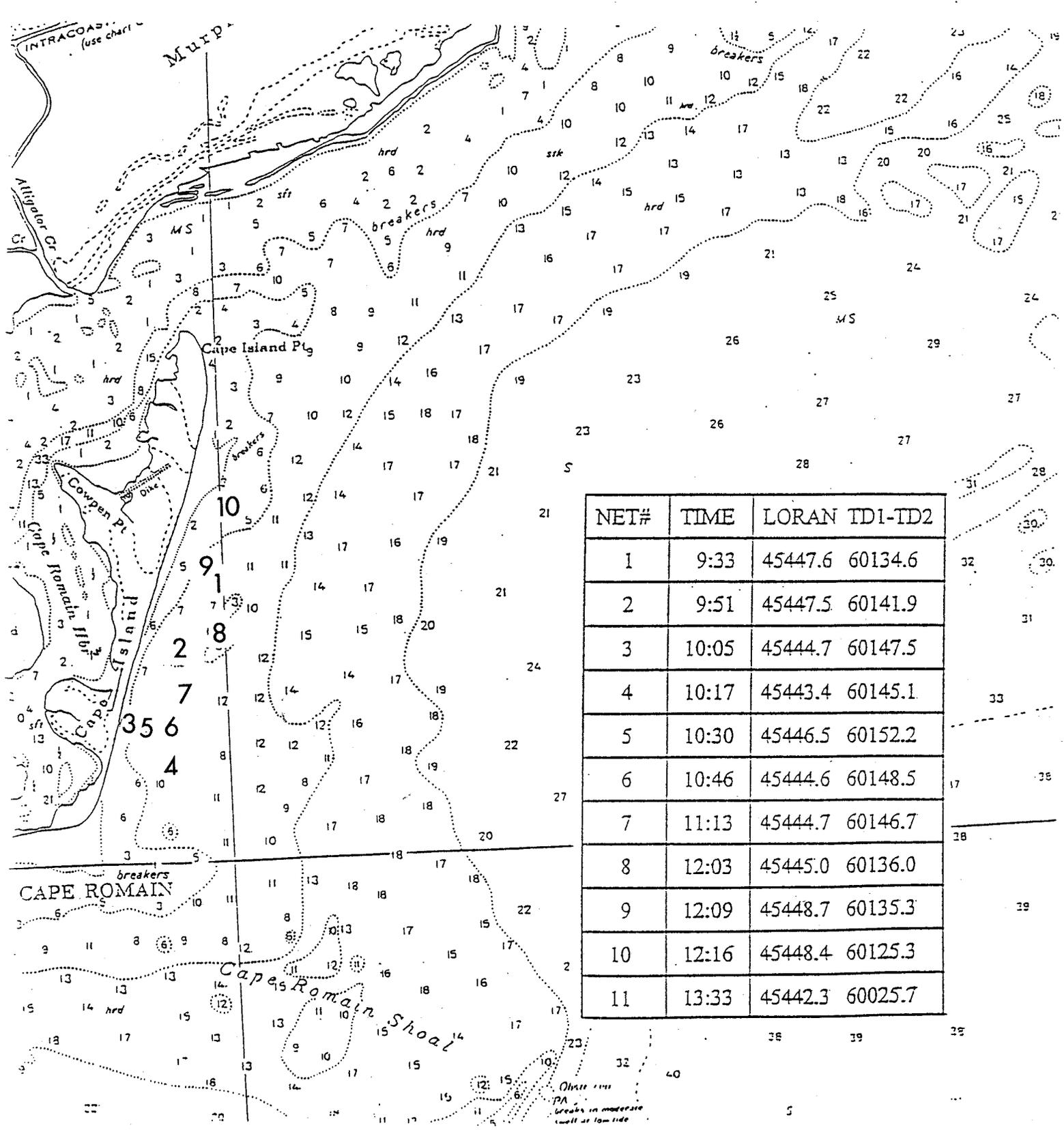
COLLECTION # 11 - MARCH 16, 1995  
OBSERVED NET LOCATIONS



COLLECTION # 11 - MARCH 16, 1995  
OBSERVED NET LOCATIONS

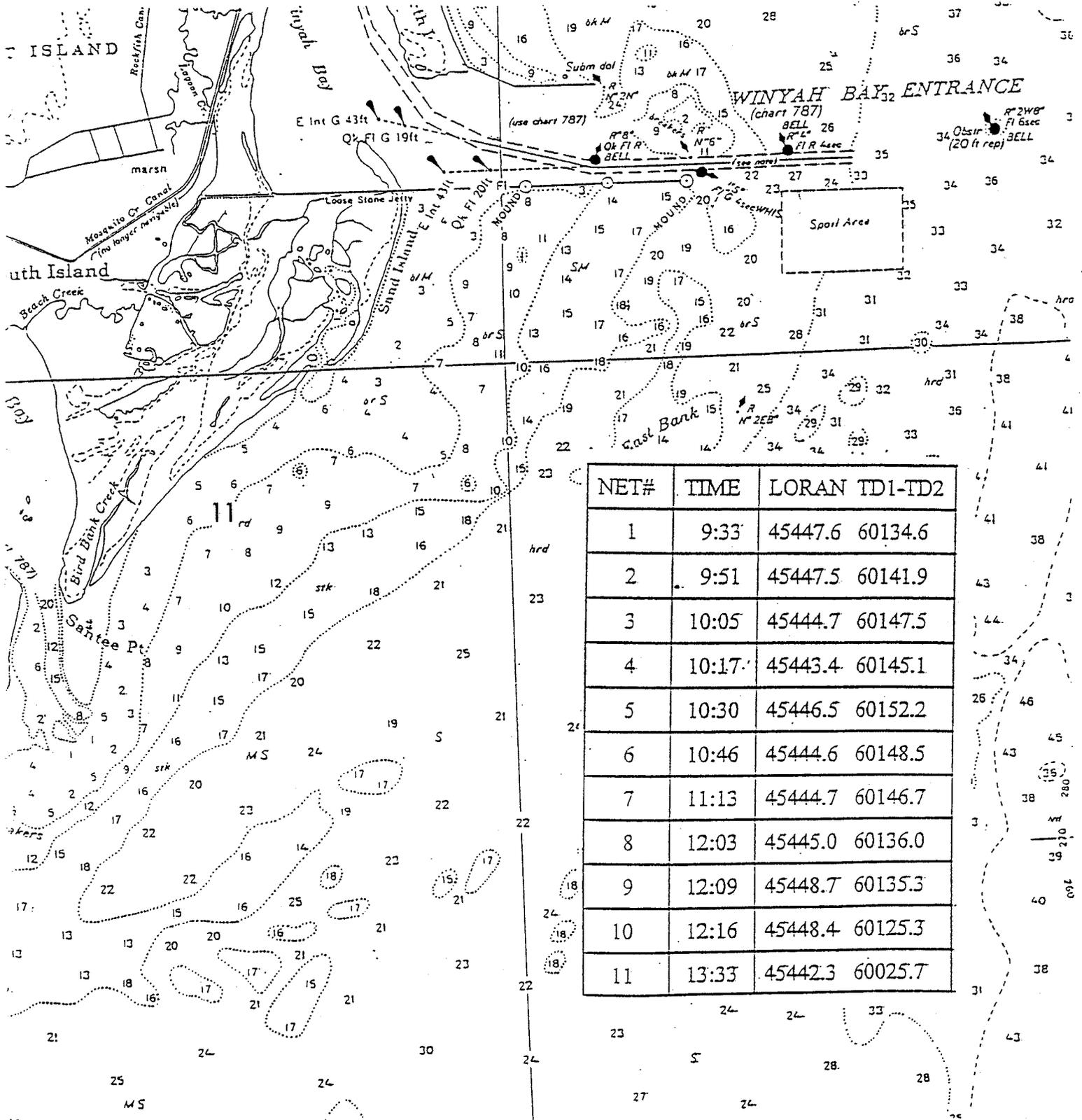


COLLECTION # 12 - MARCH 21, 1995  
OBSERVED NET LOCATIONS

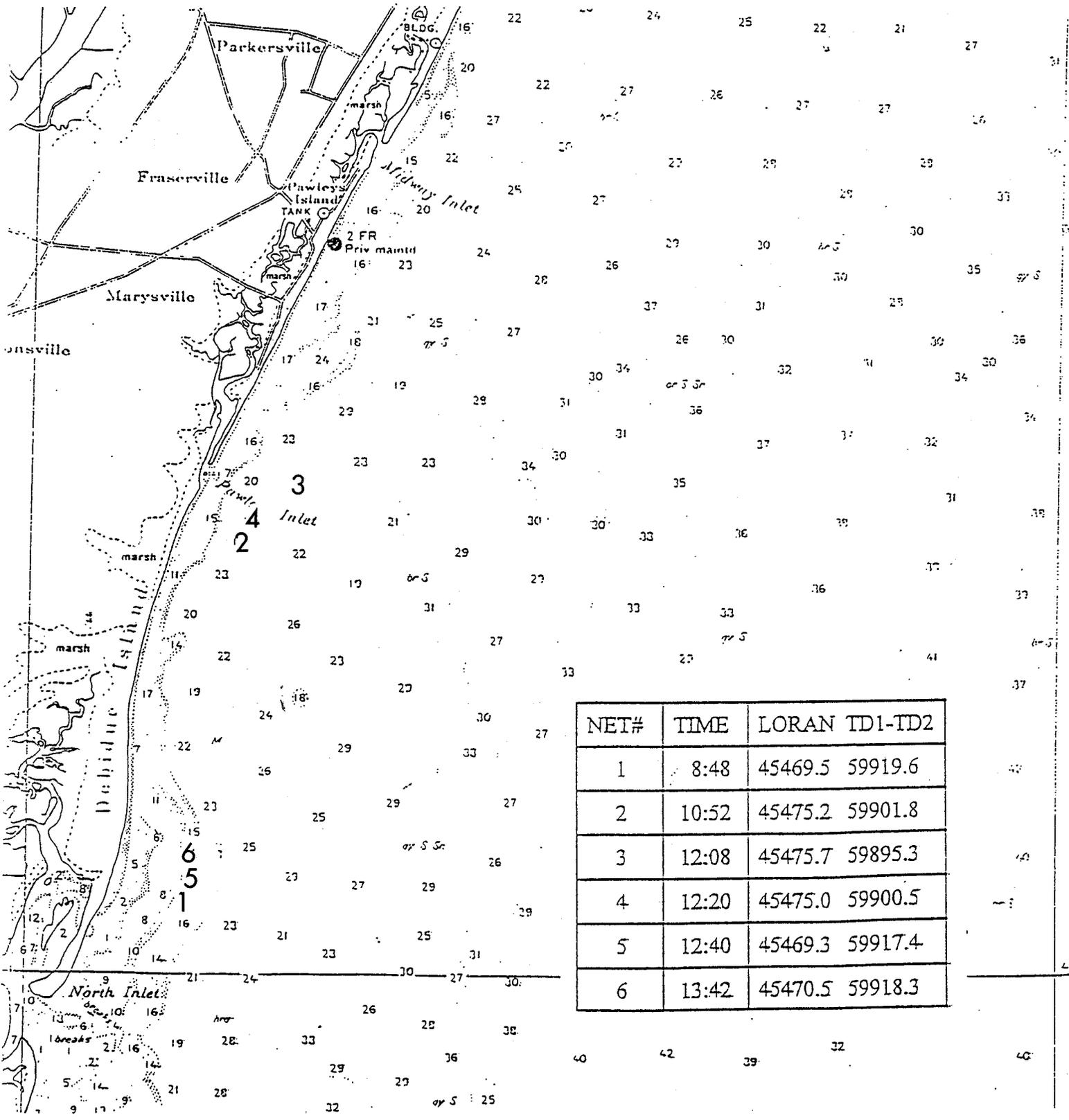


NET#	TIME	LORAN TD1-TD2
1	9:33	45447.6 60134.6
2	9:51	45447.5 60141.9
3	10:05	45444.7 60147.5
4	10:17	45443.4 60145.1
5	10:30	45446.5 60152.2
6	10:46	45444.6 60148.5
7	11:13	45444.7 60146.7
8	12:03	45445.0 60136.0
9	12:09	45448.7 60135.3
10	12:16	45448.4 60125.3
11	13:33	45442.3 60025.7

COLLECTION # 12 - MARCH 21, 1995  
OBSERVED NET LOCATIONS

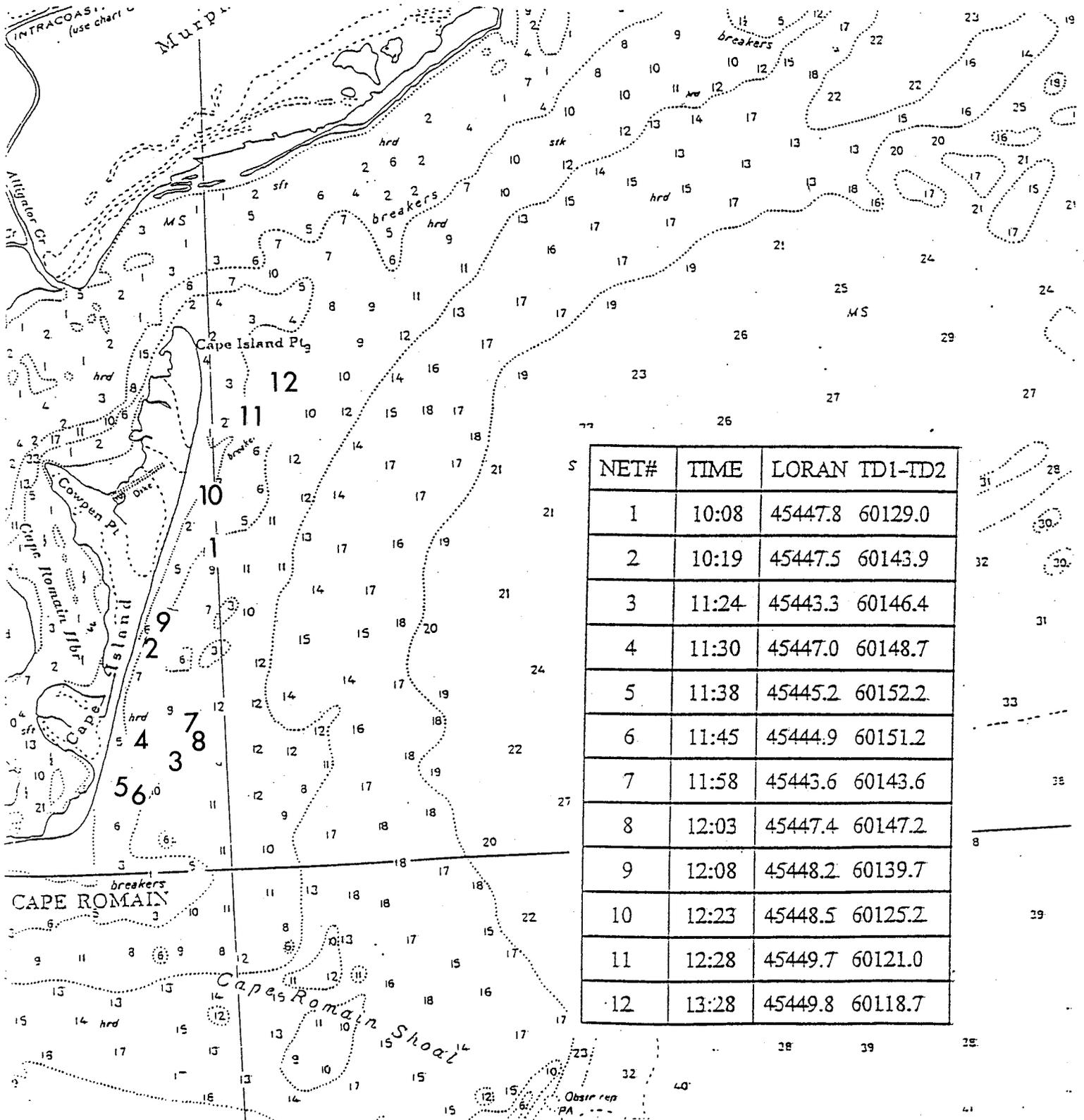


COLLECTION # 13 - MARCH 22, 1995  
OBSERVED NET LOCATIONS

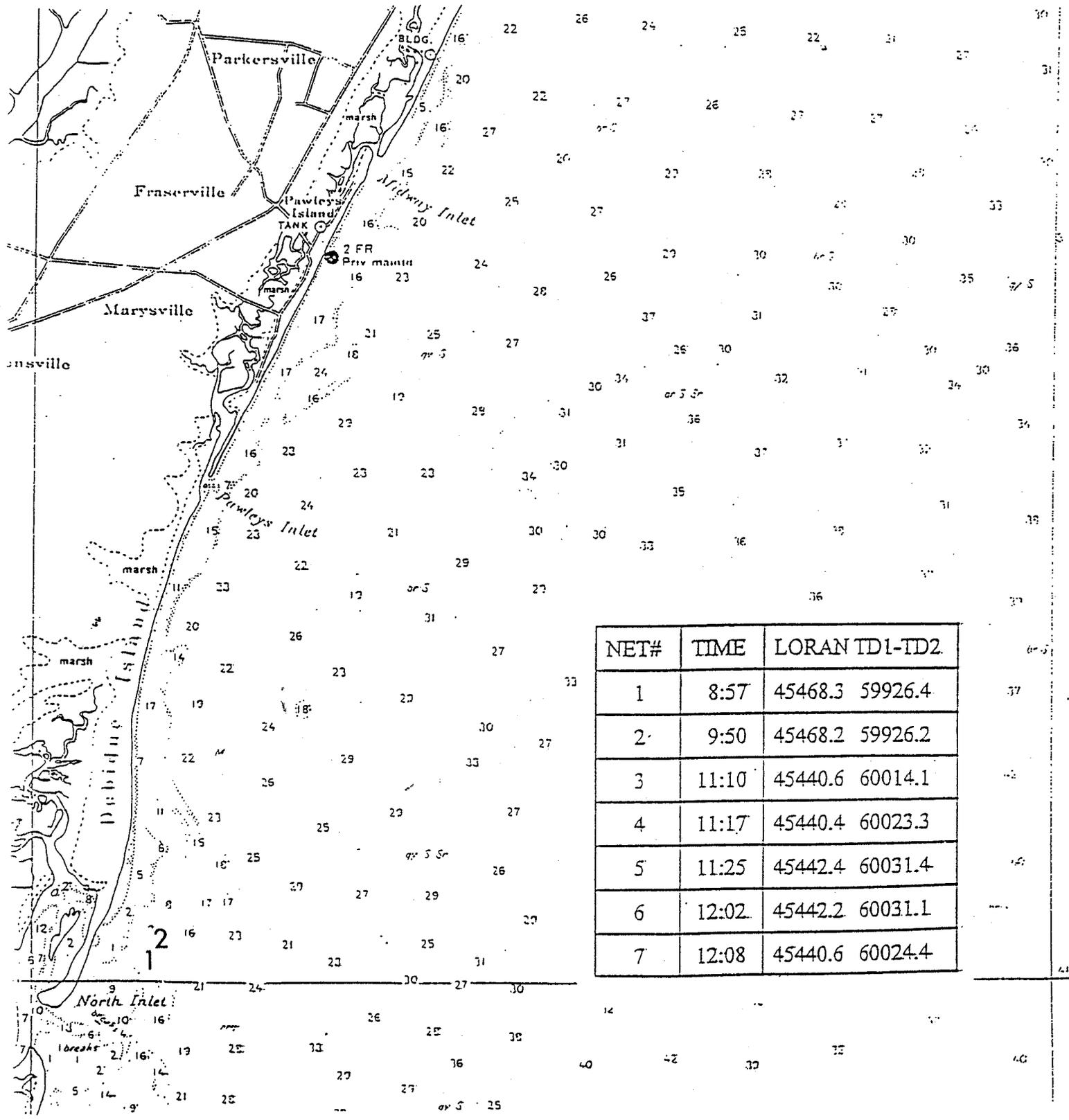


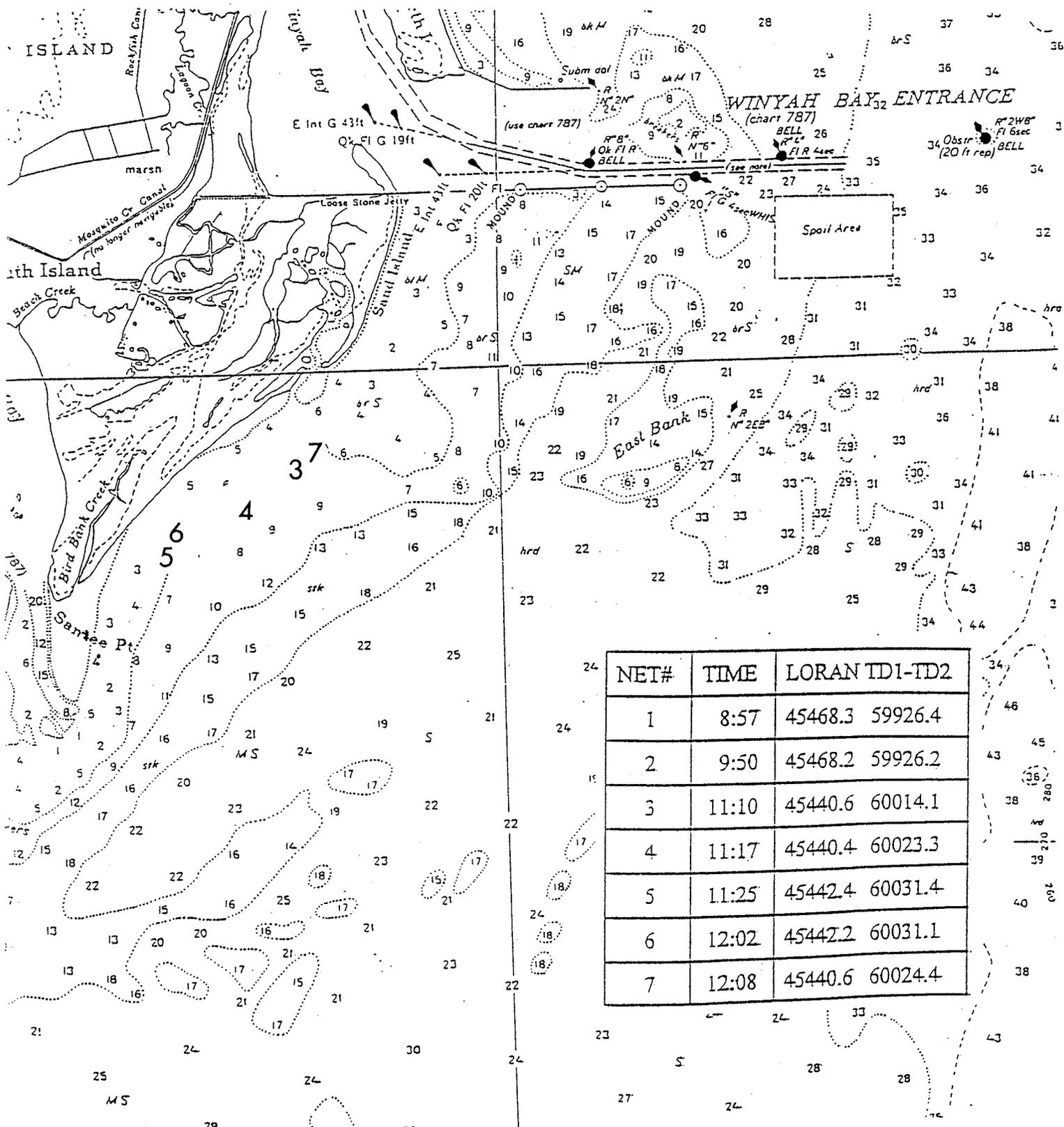
NET#	TIME	LORAN TD1-TD2
1	8:48	45469.5 59919.6
2	10:52	45475.2 59901.8
3	12:08	45475.7 59895.3
4	12:20	45475.0 59900.5
5	12:40	45469.3 59917.4
6	13:42	45470.5 59918.3

COLLECTION # 14 - MARCH 23, 1995  
OBSERVED NET LOCATIONS



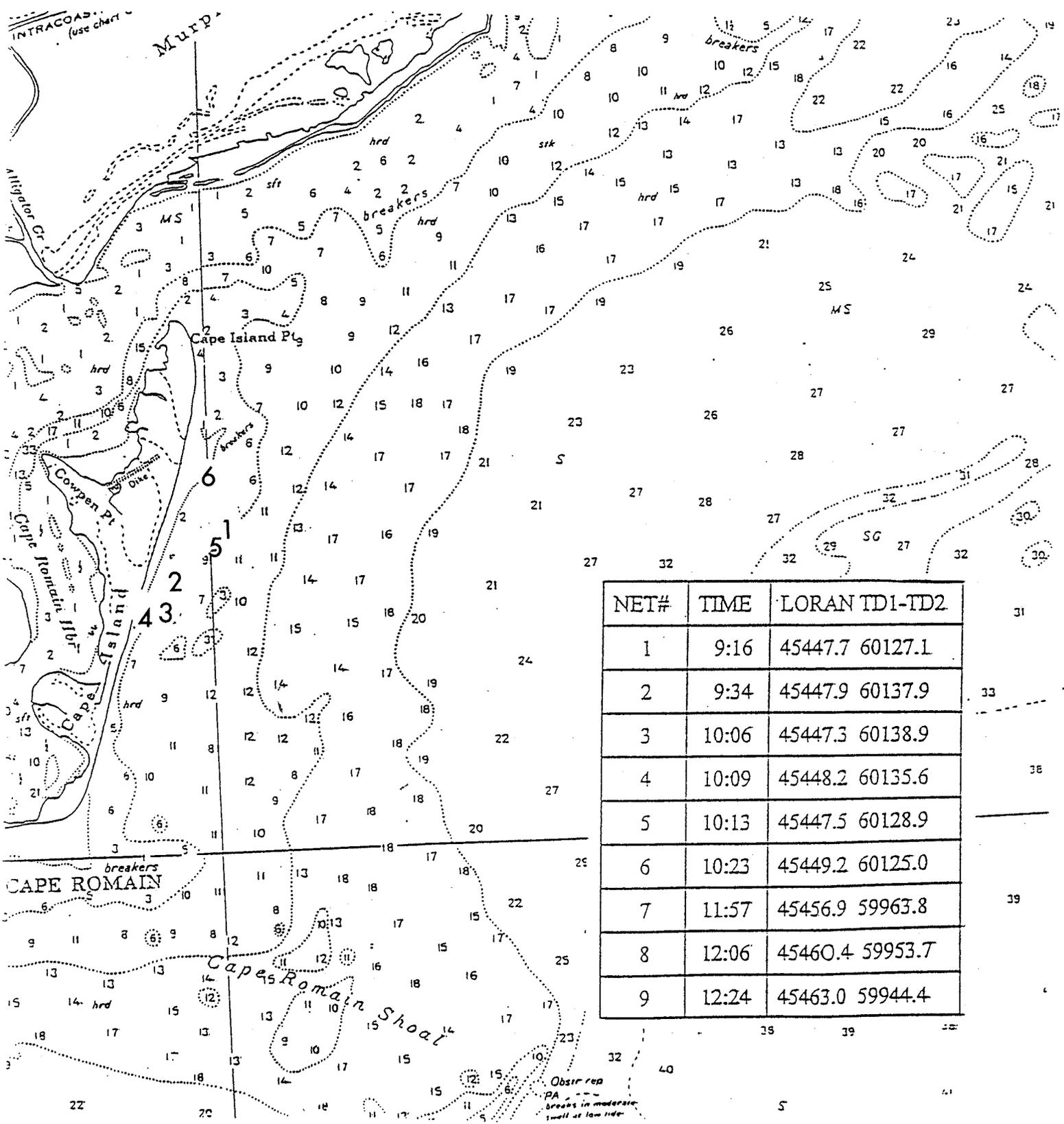
COLLECTION # 15 - MARCH 28, 1995  
OBSERVED NET LOCATIONS





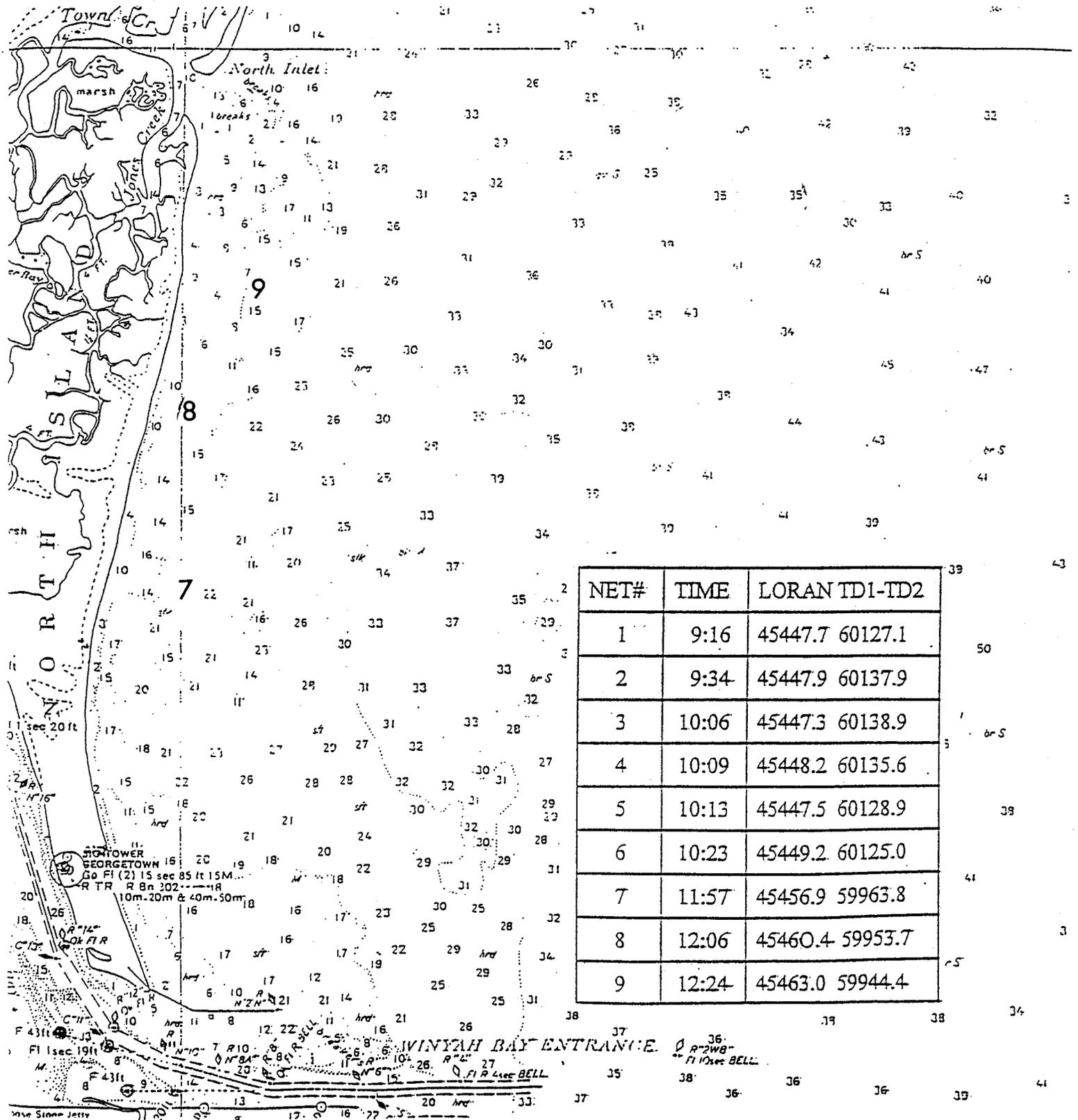
NET#	TIME	LORAN TD1-TD2
1	8:57	45468.3 59926.4
2	9:50	45468.2 59926.2
3	11:10	45440.6 60014.1
4	11:17	45440.4 60023.3
5	11:25	45442.4 60031.4
6	12:02	45442.2 60031.1
7	12:08	45440.6 60024.4

COLLECTION # 16 - APRIL 4, 1995  
OBSERVED NET LOCATIONS



NET#	TIME	LORAN TD1-TD2
1	9:16	45447.7 60127.1
2	9:34	45447.9 60137.9
3	10:06	45447.3 60138.9
4	10:09	45448.2 60135.6
5	10:13	45447.5 60128.9
6	10:23	45449.2 60125.0
7	11:57	45456.9 59963.8
8	12:06	45460.4 59953.7
9	12:24	45463.0 59944.4

COLLECTION # 16 - APRIL 4, 1995  
OBSERVED NET LOCATIONS

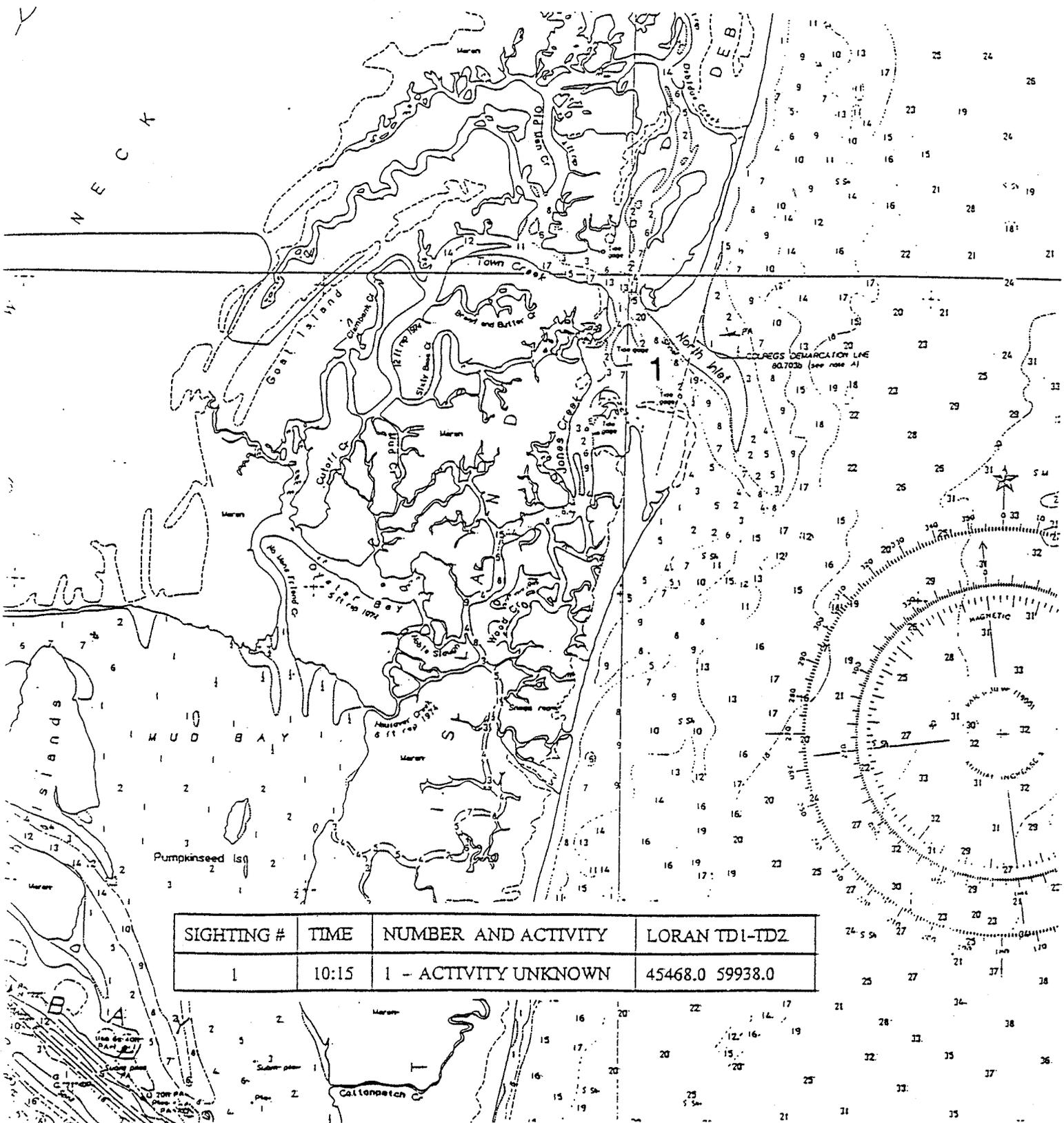


NET#	TIME	LORAN TD1-TD2
1	9:16	45447.7 60127.1
2	9:34	45447.9 60137.9
3	10:06	45447.3 60138.9
4	10:09	45448.2 60135.6
5	10:13	45447.5 60128.9
6	10:23	45449.2 60125.0
7	11:57	45456.9 59963.8
8	12:06	45460.4 59953.7
9	12:24	45463.0 59944.4

## APPENDIX F

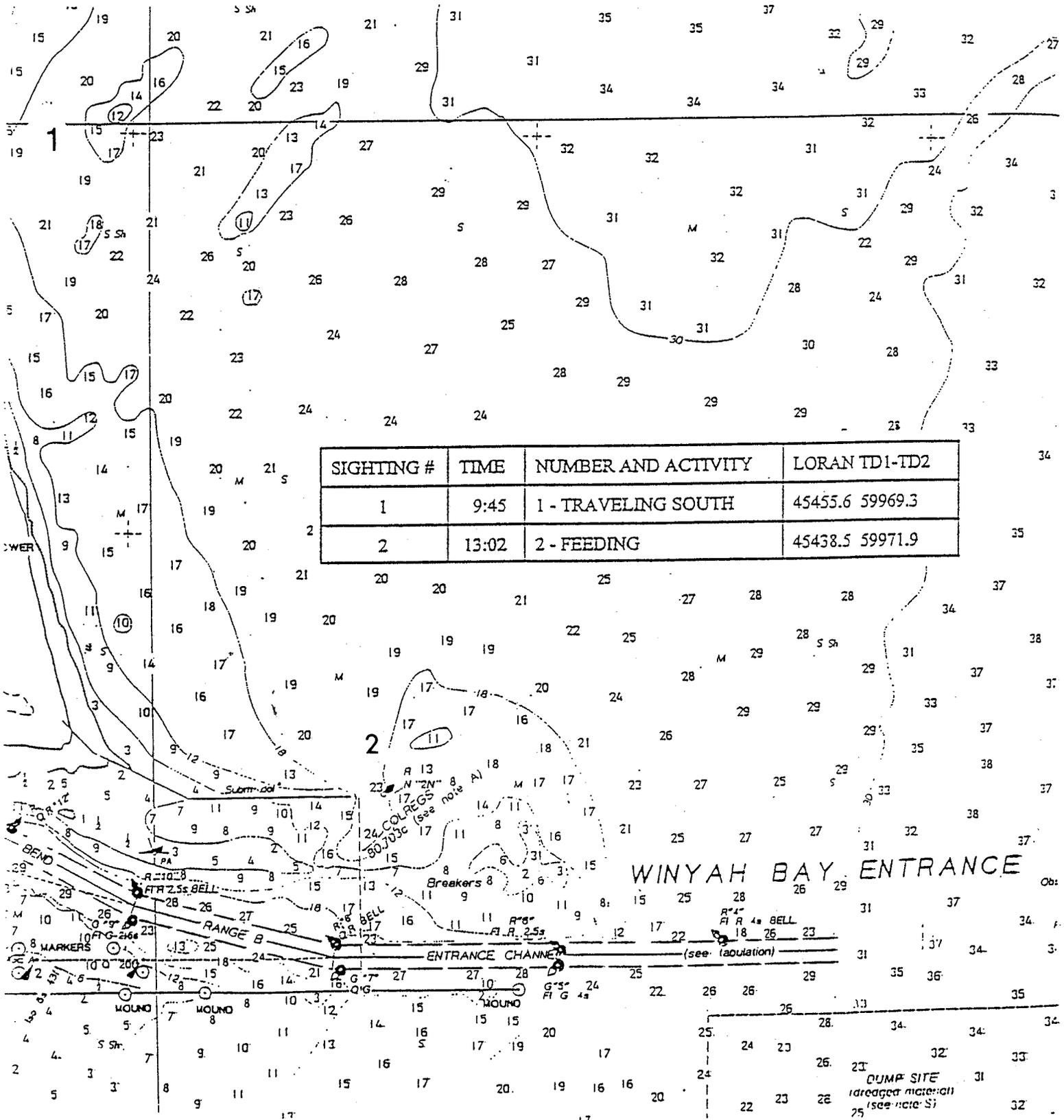
### Observed Bottlenose Dolphin Locations From Boat Surveys

COLLECTION # 2 - FEBRUARY 16, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS

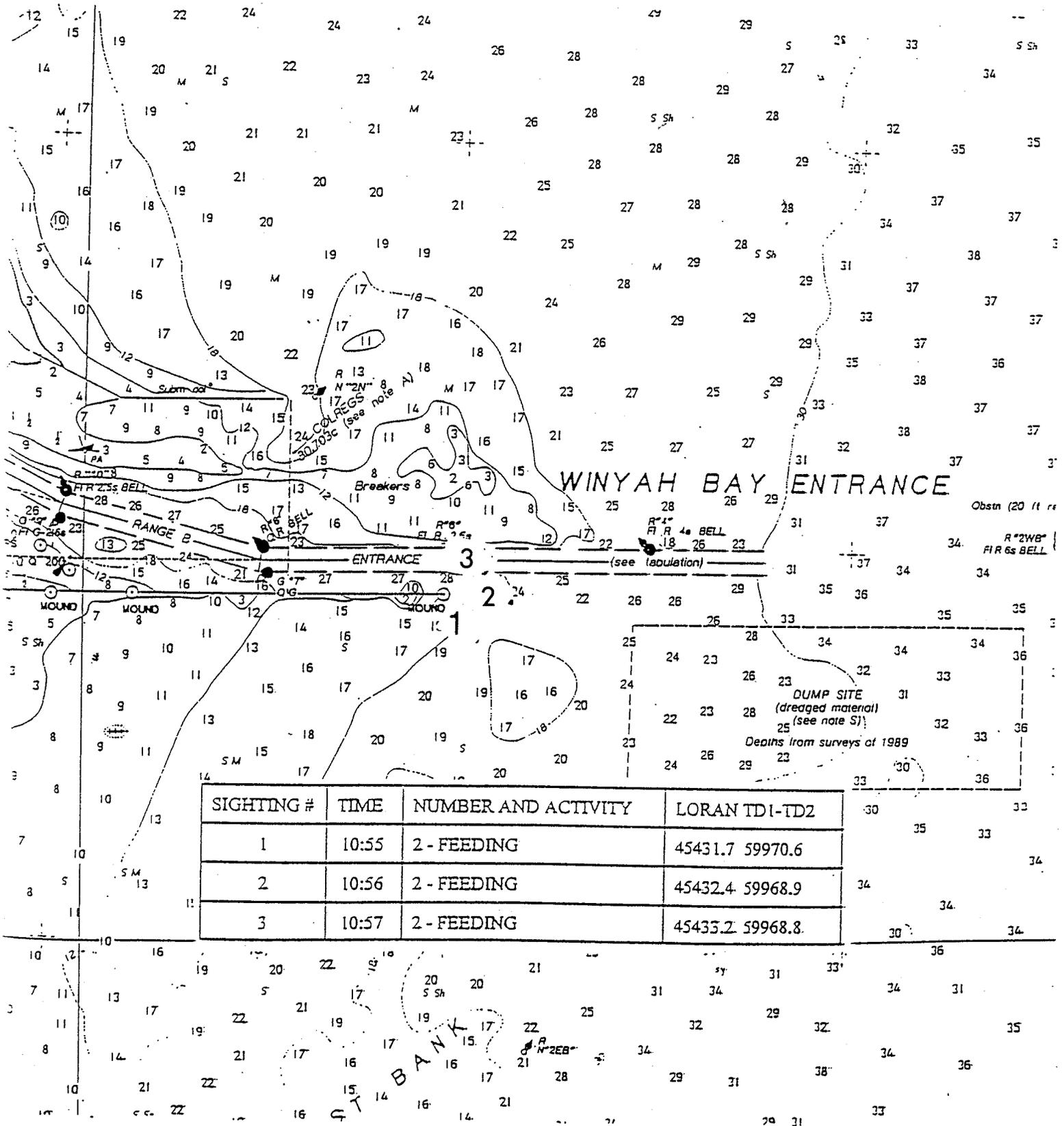


SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	10:15	1 - ACTIVITY UNKNOWN	45468.0 59938.0

COLLECTION # 6 - FEBRUARY 28, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS

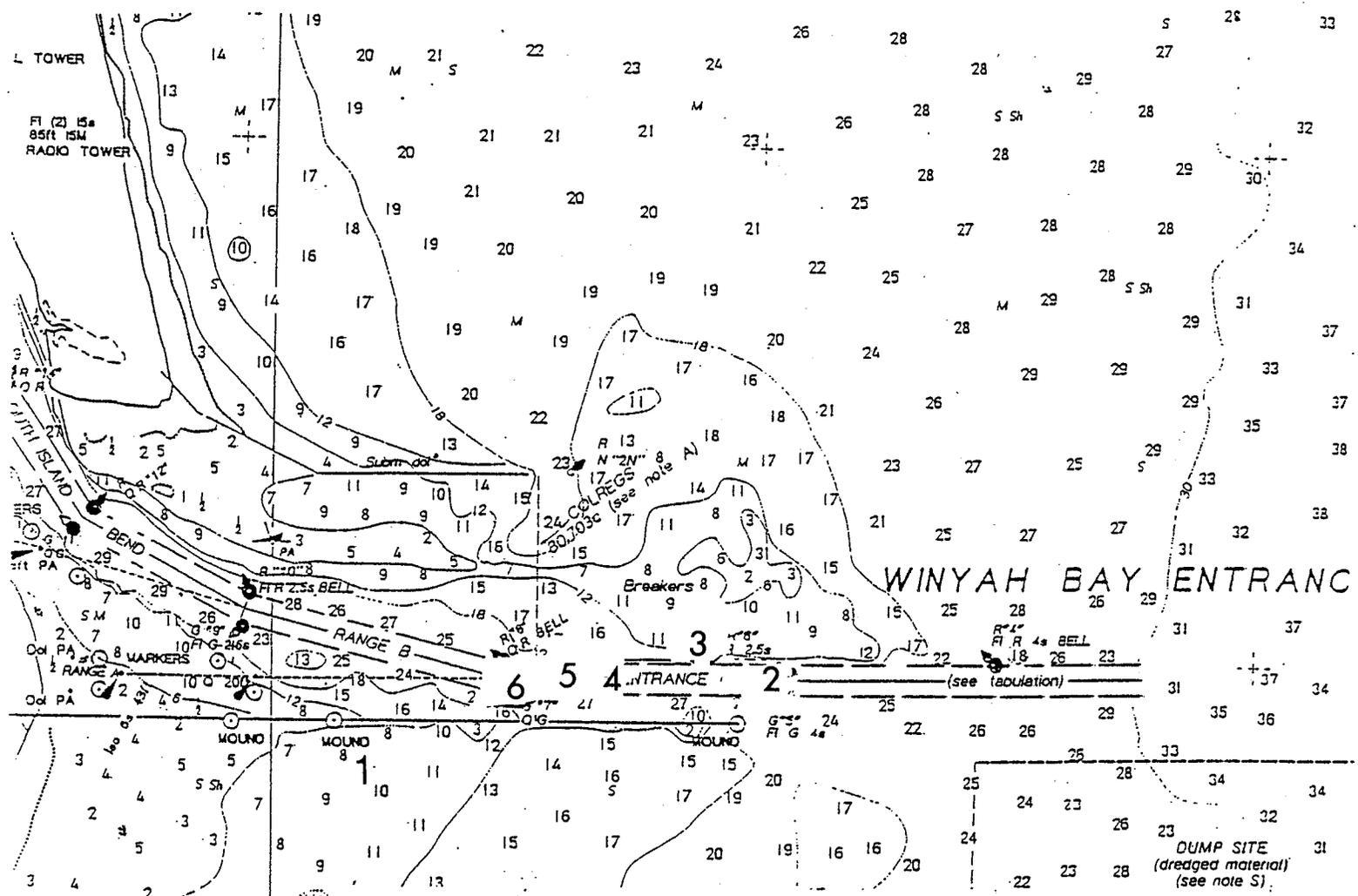


COLLECTION # 7 - MARCH 1, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS



SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	10:55	2 - FEEDING	45431.7 59970.6
2	10:56	2 - FEEDING	45432.4 59968.9
3	10:57	2 - FEEDING	45433.2 59968.8

COLLECTION # 8 - MARCH 7, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS

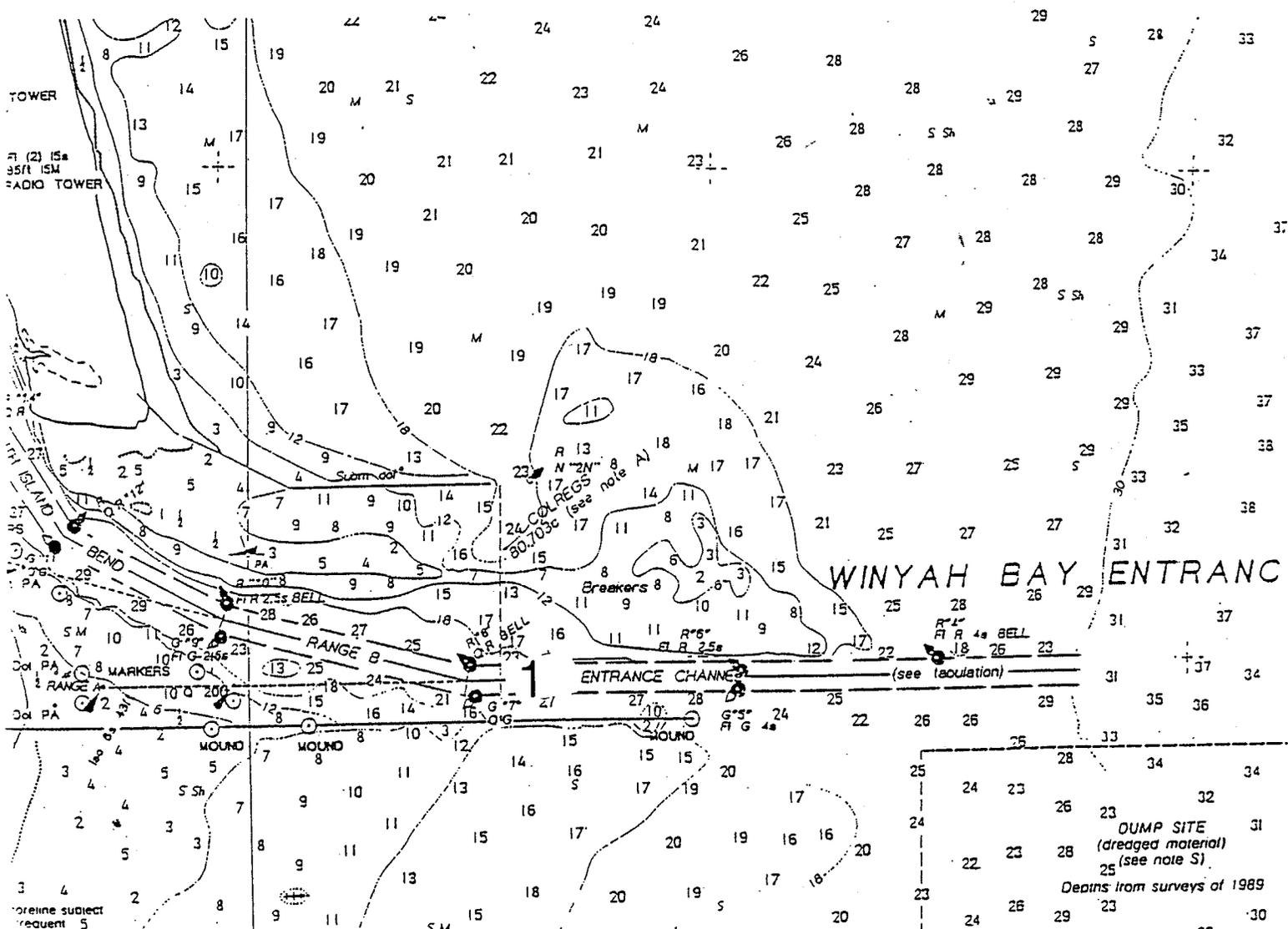


SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	12:30	1 - SLOW TRAVEL SOUTH	45438.5 60007.7
2	12:53	1 - FEEDING	45433.1 59969.8
3	13:00	1 - FEEDING	45434.0 59972.3
4	13:02	1 - FEEDING	45435.7 59976.8
5	13:03	1 - FEEDING	45436.2 59978.3
6	13:05	1 - FEEDING	45436.9 59979.5

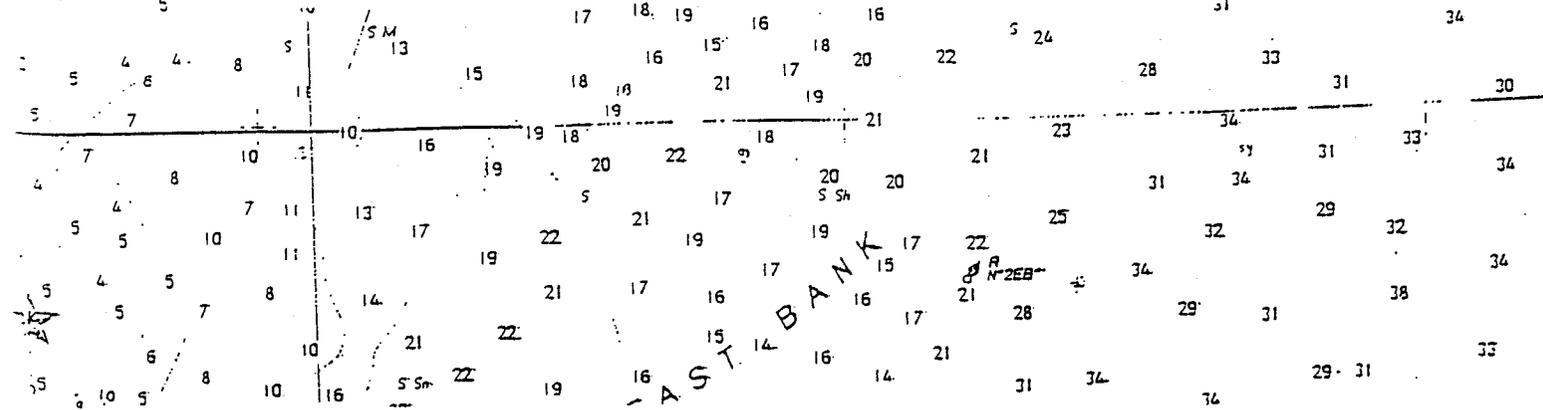
from surveys of 1989  
 30  
 33  
 32 30  
 35  
 31  
 34  
 30  
 33  
 34  
 32  
 34  
 38  
 31  
 33  
 29 31  
 34

EAST BANK

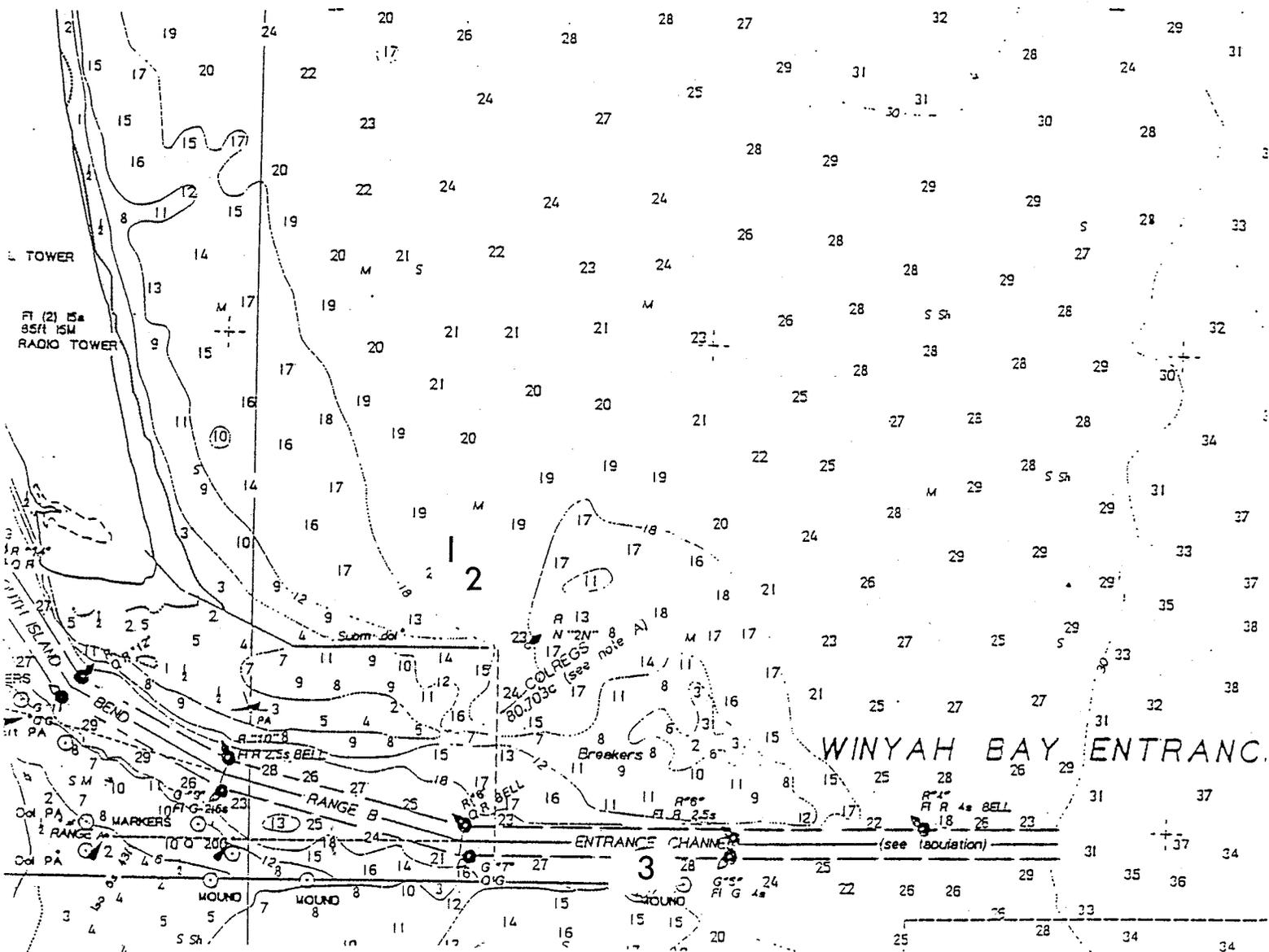
COLLECTION # 9 - MARCH 14, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS



SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	13:20	2 - ACTIVITY UNKNOWN	45435.1 59975.0



COLLECTION # 11 - MARCH 16, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS

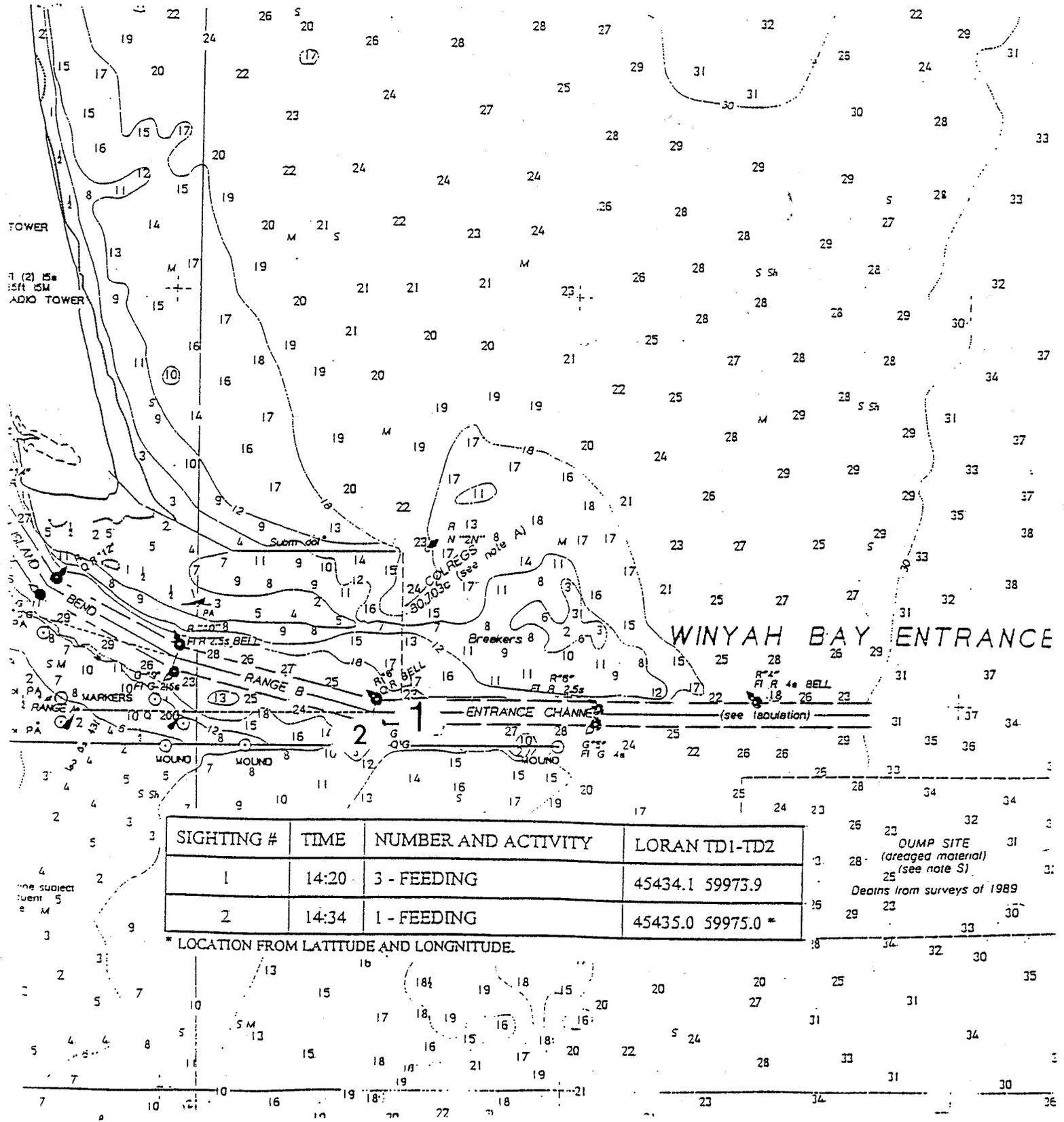


SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1- TD2
1	12:51	4 - FEEDING	45440.8 59973.1
2 *	13:00	4 - FEEDING	45439.4 59972.3
3	13:09	6 - FEEDING	45433.8 59972.4

\* SAME DOLPHINS OBSERVED IN SIGHTING # 1.

DUMP SITE  
 (dredged material)  
 (see note S)  
 Depths from surveys of 1989

COLLECTION # 12 - MARCH 21, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS

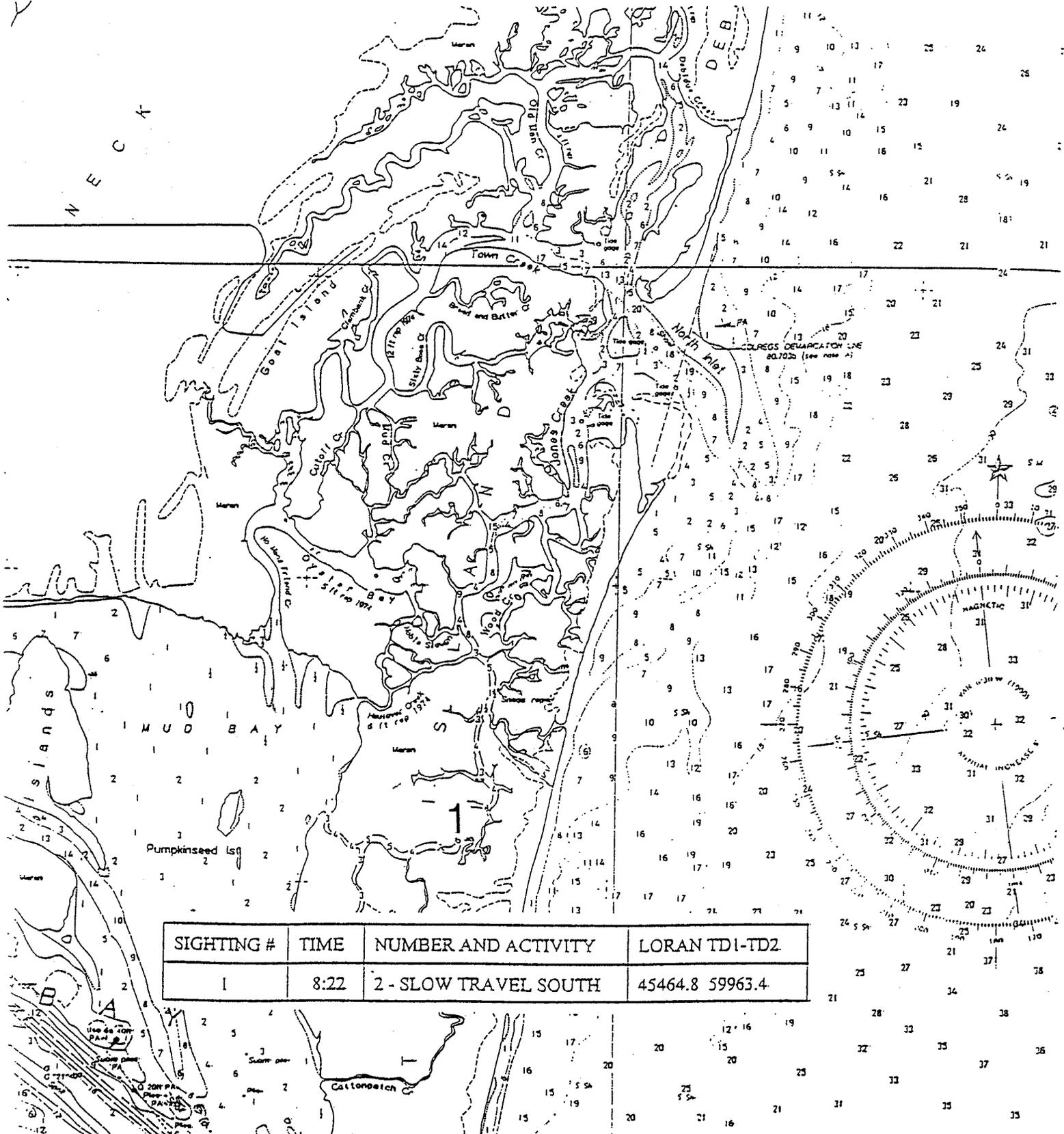


SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	14:20	3 - FEEDING	45434.1 59973.9
2	14:34	1 - FEEDING	45435.0 59975.0 *

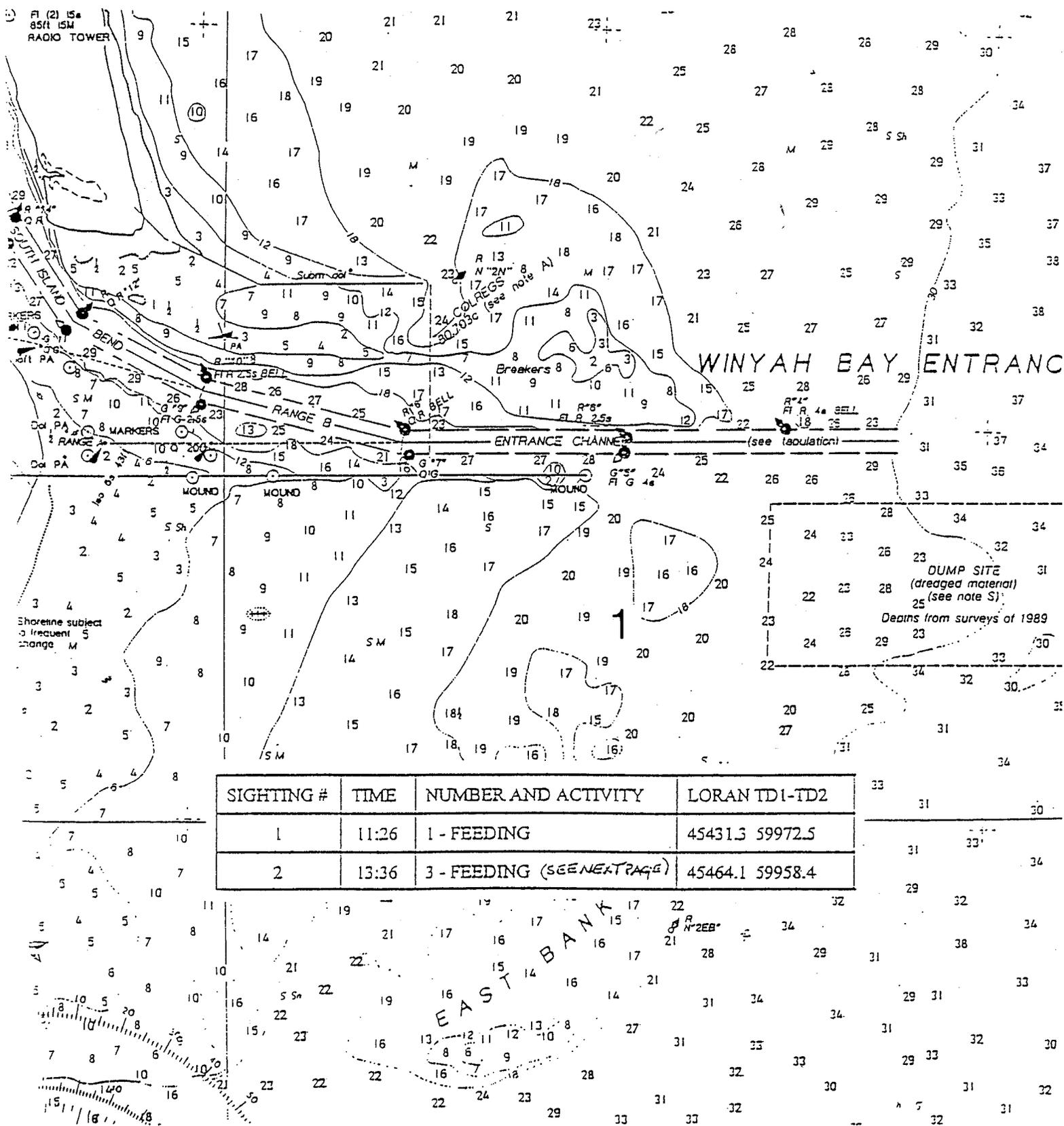
\* LOCATION FROM LATITUDE AND LONGITUDE.

DUMP SITE  
 (dredged material)  
 (see note S1)  
 Debris from surveys of 1989

COLLECTION # 13 - MARCH 22, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS

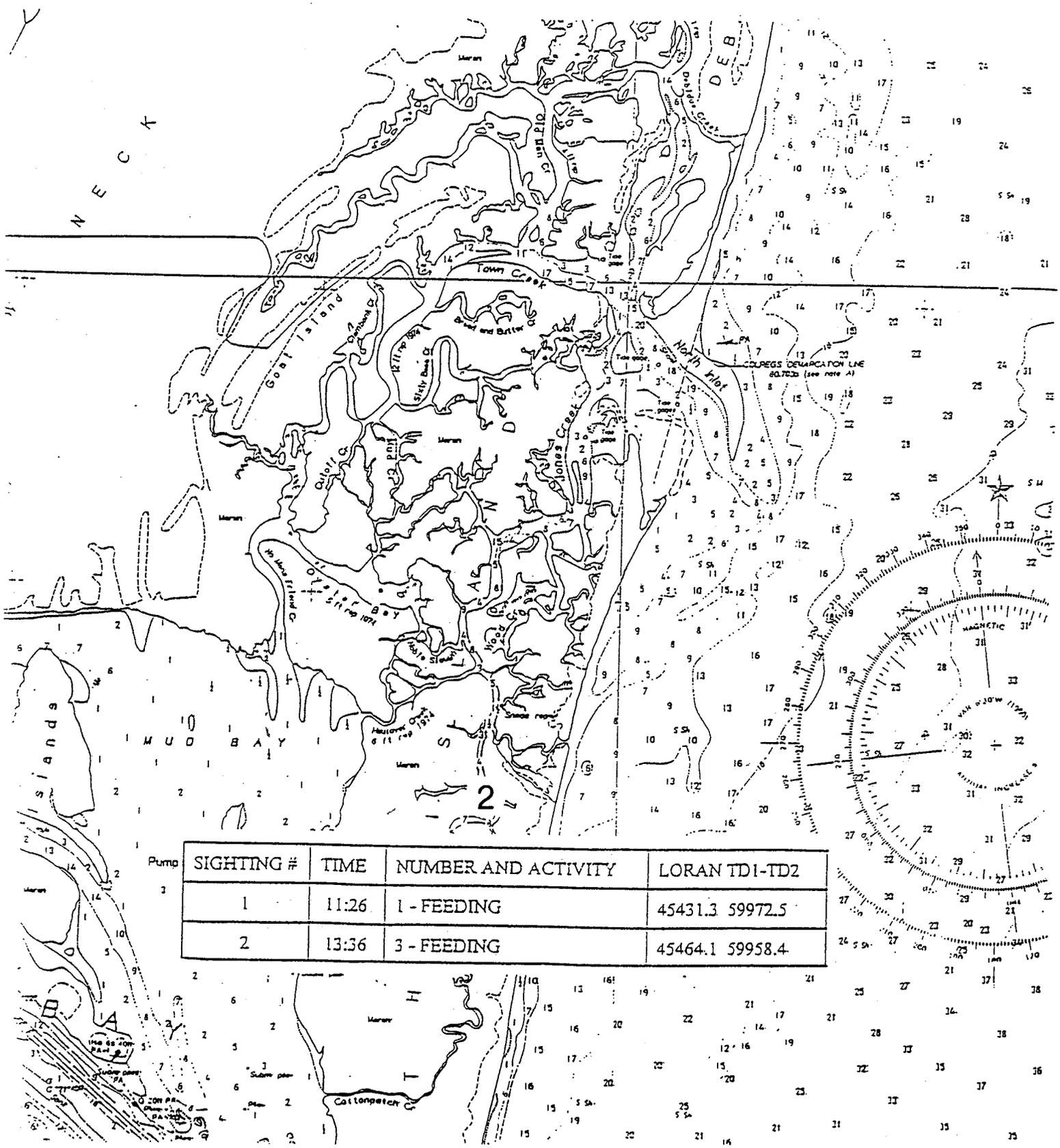


COLLECTION # 16 - APRIL 4, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS



SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	11:26	1 - FEEDING	45431.3 59972.5
2	13:36	3 - FEEDING (SEE NEXT PAGE)	45464.1 59958.4

COLLECTION # 16 - APRIL 4, 1995  
 BOTTLENOSE DOLPHIN OBSERVATIONS



SIGHTING #	TIME	NUMBER AND ACTIVITY	LORAN TD1-TD2
1	11:26	1 - FEEDING	45431.3 59972.5
2	13:36	3 - FEEDING	45464.1 59958.4