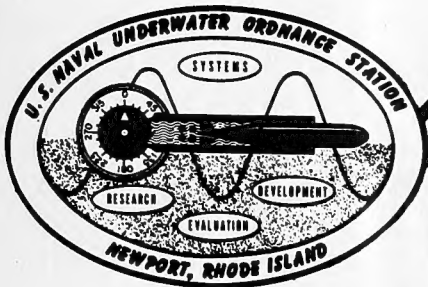


LAGRANGIAN CURRENT MEASUREMENTS IN THE
NORTHEAST PROVIDENCE CHANNEL AND THE
TONGUE OF THE OCEAN, BAHAMAS
14 FEBRUARY TO 6 MARCH 1963
PRELIMINARY REPORT

Sept. 63



U.S. NAVAL
UNDERWATER ORDNANCE STATION
NEWPORT, RHODE ISLAND

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U. S. NAVAL UNDERWATER ORDNANCE STATION
NEWPORT, RHODE ISLAND

TECHNICAL MEMORANDUM

LAGRANGIAN CURRENT MEASUREMENTS
IN THE NORTHEAST PROVIDENCE CHANNEL
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14 FEBRUARY TO 6 MARCH 1963 - PRELIMINARY REPORT



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Task Assignment No.
RUTO-3E-000/219 1/SF-099-03-02 and
ASW Oceanographic Research RU22-2E-000/219 1R004-03-01

UNCLASSIFIED

FOREWORD

In the Atlantic Undersea Test and Evaluation Center (AUTEC) development program, the Naval Underwater Ordnance Station (NUOS) is responsible for the design, installation, test, and evaluation of an underwater weapons tracking range. In order to provide accurate tracking data on test vehicles, the information obtained by the underwater instrumentation must be correlated with the oceanographic environment. NUOS, in a cooperative effort with the Woods Hole Oceanographic Institution (WHOI), obtained water current data during February and March 1963, using the parachute drogue system in the Northeast Providence Channel and Tongue of the Ocean, Bahamas.

This preliminary report describes the purpose of the cruise, the drogue system, and the type of navigation used in tracking the drogues. The raw data are included in the Appendix. Analysis of the data will be the subject of a subsequent report. This work was accomplished under BUWEPS Task Assignment Nos. RUT0-3E-000/219 1/SF-099-03-02 and ASW Oceanographic Research RU22-2E-000/219 1/R004-03-01.

ACKNOWLEDGMENT

The able assistance of Mr. Seward Johnson, owner of the OCEAN PEARL, Mr. R. Schlichtenmaier, Captain of the H.J.W. FAY, and their crews helped make this program a success, and is gratefully acknowledged. Special thanks are due Mr. John Bruce of the Woods Hole Oceanographic Institution for sharing the responsibility and offering many helpful suggestions.

SUMMARY

The Naval Underwater Ordnance Station is responsible for the design, installation, test, and evaluation of an underwater weapons tracking range for the Atlantic Undersea Test and Evaluation Center (AUTEC). As this work requires a knowledge of the environmental factors affecting deep water tracking, a program was established to gather additional data on the water currents in the Northeast Providence Channel and selected areas in the Tongue of the Ocean, Bahamas.

Water current measurements were taken during February and March 1963 by tracking parachute drogues along five transects in the areas selected. The drogues were placed at various positions and depths (from surface to 1500 meters) along each transect, and were tracked for periods of one to four days. Although it had been planned to track each drogue for a longer period of time (three to five days), the weather (high winds) proved to be a limiting factor.

A total of 27 drogues (all identical in construction) were tracked, and over 500 position fixes were taken. When the surface floats were recovered, a tension was noted on the suspension wire prior to cutting. This indicated that the parachute was still open and that the run was successful.

Two vessels were used to track the drogues which made it possible to: make a greater number of observations during the time allocated for the program; obtain the first synoptic, drogue water current measurements taken in the area; and acquire the quasi-continuous measurements of the currents that were desired in order to determine meaningful flow patterns.

Decca Hi-Fix (a short range, high precision, position-fixing system) was used to determine the positions of the surface floats relative to known landmarks at various intervals along the drogue tracks. Standard navigation radar fixes were taken simultaneously with the Hi-Fix readings to provide back up information, and to position the surface floats if the Hi-Fix system failed or the range was too great. However, the Decca Hi-Fix position fixes were quite adequate for tracking the drogues throughout the areas covered.

Although information on the water characteristics at the time and place each measurement was taken would be valuable, no effort was made to assess these characteristics since the time involved would interfere with the planned program, and hydrographic station data are available for the areas of interest. These data cover all months over a period of years and could be used in conjunction with the water current data obtained to provide a more complete analysis.

Since this is a preliminary report, only raw data and descriptions of the equipment and procedures are presented. A subsequent report will include a final analysis of the data in an attempt to answer the following questions:

1. Can the motion of the water in the Northeast Providence Channel be traced to the motion of the water in the Tongue of the Ocean (TOTO) (or vice versa)?
2. What is the "mixing length" of the predominant eddies in TOTO?
3. What is the general magnitude and intensity of the horizontal and vertical current shear in the central region of TOTO?
4. To what extent (and time scale) are turbulent shears (normal to the bank walls) causing mixing and transport of bank water into the AUTECH region?
5. How is the wind drift pattern related to tidal data?

INTRODUCTION

Since accurate tracking of test vehicles in the deep water range at AUTEC will depend in part on correlating the effects of the oceanographic environment with information obtained by the underwater instrumentation, additional data on the environmental factors involved were required. To learn more about one of these factors, parachute drogues were set and tracked during the period 14 February to 6 March 1963 in the Northeast Providence Channel and selected areas of the Tongue of the Ocean, Bahamas.

The purpose of this program was to gather data on the water currents which could be used in an attempt to answer the following questions:

1. Can the motion of the water at the Northeast Providence Channel be traced to the motion of the water in Tongue (or vice versa)?
2. What is the "mixing length" of the predominant eddies in The Tongue?
3. What is the general magnitude and intensity of horizontal and vertical current shear in the central region of the Tongue?
4. To what extent (and time scale) are turbulent shears (normal to the bank walls) causing mixing and transport of bank water into the AUTEC region?
5. How is the wind drift pattern related to tidal data?

Two vessels were used during the program. The OCEAN PEARL (Figure 1) is a privately owned ketch capable of speeds up to 9 knots under power. This vessel, used by the Woods Hole Oceanographic Institution (WHOI), was under the direction of Mr. John Bruce, WHOI. The H.J.W. FAY (Figure 2) is a research vessel capable of speeds up to 18 knots. This vessel, on contract to the Naval Underwater Ordnance Station (NUOS) from Marine Acoustical Services, Inc., Miami, Florida, was under the direction of Mr. G. S. Cook, NUOS. Both vessels were equipped with Decca Navigation radar and standard ship-to-shore transceivers. Decca Hi-Fix receivers were temporarily installed on each vessel and were used in combination with the radars to track the drogues. Thus, if one system failed, tracking could be continued with the other system alone.

With two vessels tracking their respective drogues simultaneously at various distances from each other, it was possible to make synoptic current measurements (using drogues) for the first time in the area. In addition, the program was not interrupted when one vessel had to return to port. This was important, since quasi-continuous measurements were desirable in order to determine meaningful flow patterns.



The OCEAN PEARL

FIGURE 1



FIGURE 2

The H. J. W. FAY

The areas covered, the equipment used, and the methods employed to obtain the water current measurements are described in this preliminary report. In addition, the raw data are presented in Appendix A. A subsequent report on this program will include an analysis of the data in an effort to answer the previously posed questions.

AREAS

For the purpose of this program, five areas were selected, and water current measurements were taken along transects in these areas (See Figure 3).

The first transect was positioned between Northern Eleuthera (Egg Island) and Great Abaco Island (Hole-in-the-Wall). This transect was selected in order to define water motion at the entrance to Northeast Providence Channel.

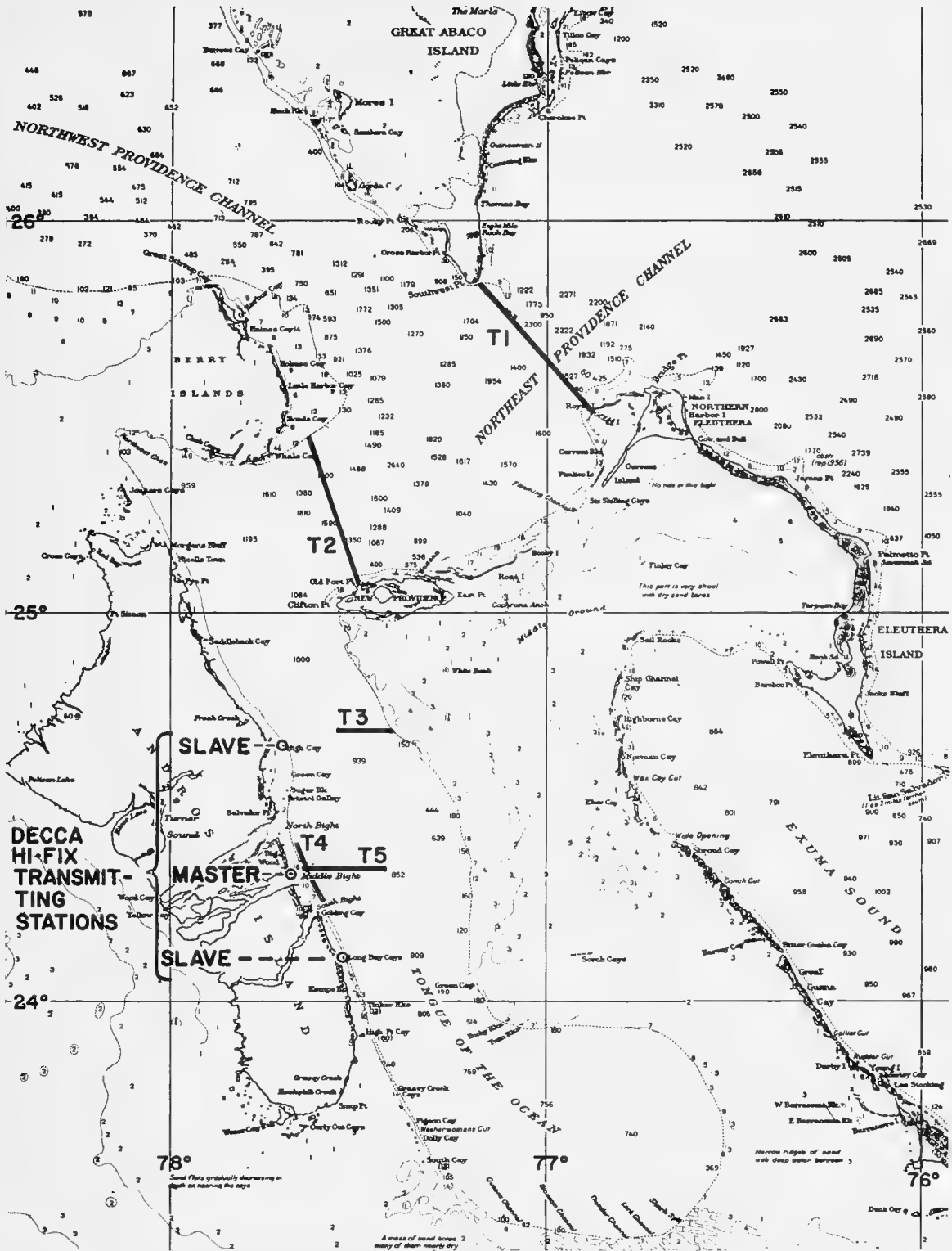
The second transect was positioned along a line bearing 343° T from Old Fort Point (New Providence Island), and terminating east of the Berry Islands at the 100 fathom curve.

The third transect was positioned in the eastern part of TOTO (east of the longitudinal axis and extending eastward toward the bank along latitude $24^{\circ} 40' N$).

The fourth transect was positioned parallel to the bank about three miles east of Middle Bight, Andros Island. Only three drogues (set at a depth of 10 meters) were tracked, but observations were taken at much shorter time intervals than along the other transects. This experiment was conducted in an attempt to examine small scale turbulent fluctuations in the surface flow. It should be noted that the drogues set along the fourth transect were tracked simultaneously with the drogues set along the third transect.

The fifth transect was positioned in the western part of TOTO (west of the longitudinal axis and extending westward toward the bank along latitude $24^{\circ} 15' N$). The drogues set along this transect (after tracking was completed along the fourth transect) were also tracked simultaneously with the drogues set along the third transect.

A total of 27 drogues were set and tracked along these transects, and 19 of the surface floats were recovered. The drogues were placed at predetermined depths to provide information on the character and velocity of the water currents throughout the water column. The number of drogues tracked along each transect, the depth at which each drogue was set, and the total tracking time per drogue is tabulated in Table 1.



Transects Where Drogue Current Measurements Were Taken

FIGURE 3

Table 1. Drogues, Depths, and Tracking Time

Transect	Drogue Identification No.	Depth (Meters)	Total Tracking Time (hours)	Remarks
1	V	10	93.0	Surface float recovered
	3	200	81.3	Surface float recovered
	2	200	20.4	Lost
	4	600	26.1	Lost
	8	600	70.5	Surface float recovered
	X	1500	89.1	Surface float recovered
	Y	1500	51.1	Surface float recovered
	Z	1500	36.0	Lost
2	F	10	67.7	Lost
	3II	10	48.0	Lost
	M	200	95.1	Surface float recovered
	R	200	96.0	Surface float recovered
	G	600	99.3	Surface float recovered
	T	600	94.8	Surface float recovered
	1	1500	70.4	Lost
	SR	1500	96.7	Surface float recovered
3	RII	200	121.5	Surface float recovered
	3III	500	65.8	Surface float recovered
	TII	1000	72.0	Surface float recovered
	SRII	1000	66.0	Surface float recovered
4	C	10	22.5	Lost
	K	10	70.8	Surface float recovered
	YII	10	47.8	Surface float recovered
5	P	200	73.7	Surface float recovered
	U	500	34.5	Lost
	N	1000	74.5	Surface float recovered
	L	1400	49.3	Surface float recovered

DESCRIPTION OF THE DROGUES

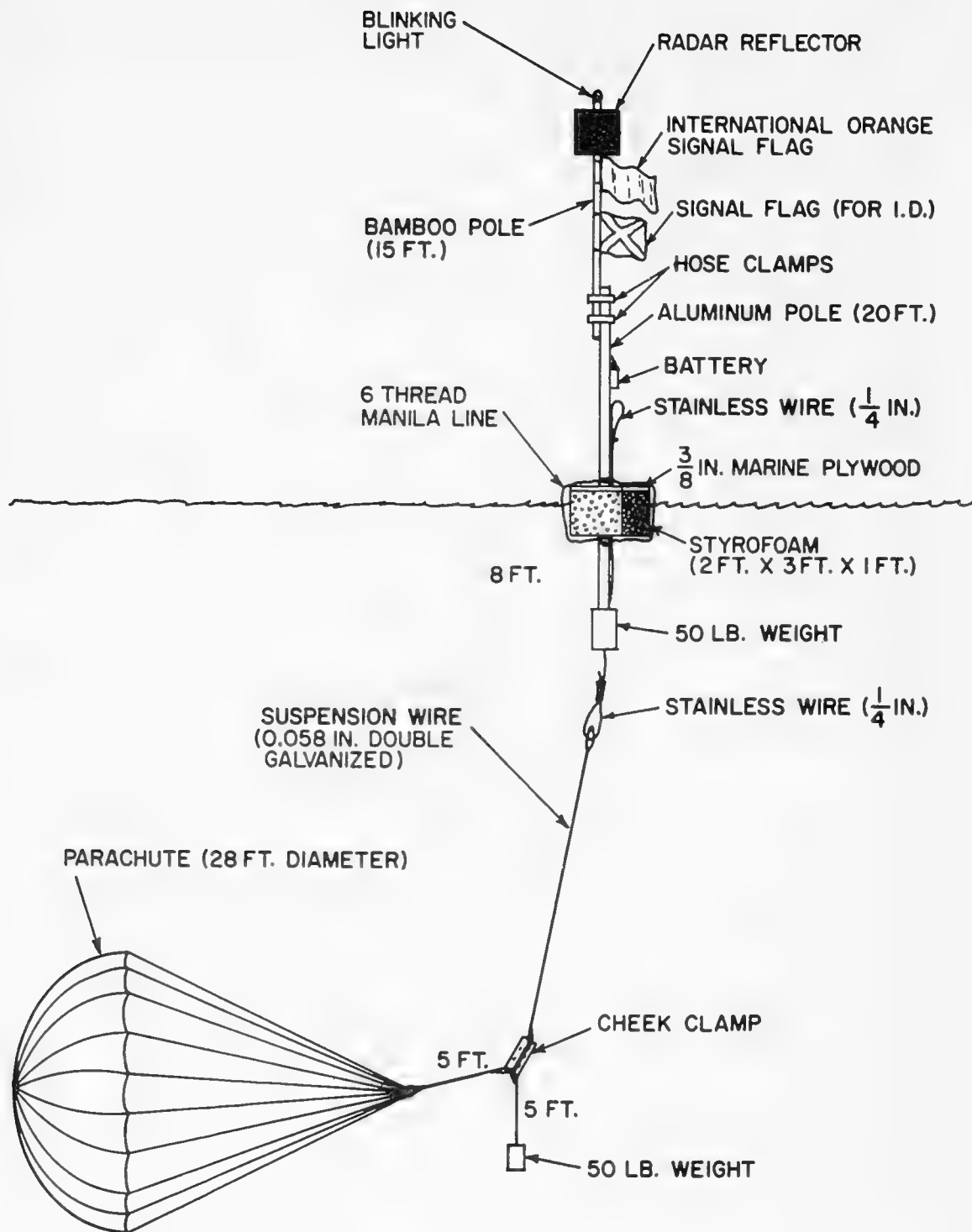
Parachute drogues were designed that would have a large drag area (approximately 45 square meters) at the depths where the water currents would be measured, as contrasted with a drag area (approximately 3 square meters) where the surface float would be exposed to the surface water and the wind. At the same time the float and structure of the drogue above the water was designed to be clearly visible at the surface. A diagram of this design, which is comparable with that reported by Ref. 1, is shown in Figure 4.

The surface floats were constructed of styrofoam (3 feet long, 2 feet wide, and 1 foot thick) covered with 3/8-inch marine plywood, and ballasted by a 50-pound weight suspended 8 feet below the float. Each float supported a mast which extended approximately 24 feet above the water and consisted of a 20-foot length of aluminum pipe and a 15-foot bamboo pole.

The aluminum pole, with the 50-pound ballast weight mounted on the lower end, was positioned through a center hole in the float, and was held in place by a clamp and shackle combination above the plywood cover and by a 1/4-inch manila line bent around the float and secured through the shackle (see Figure 5A).

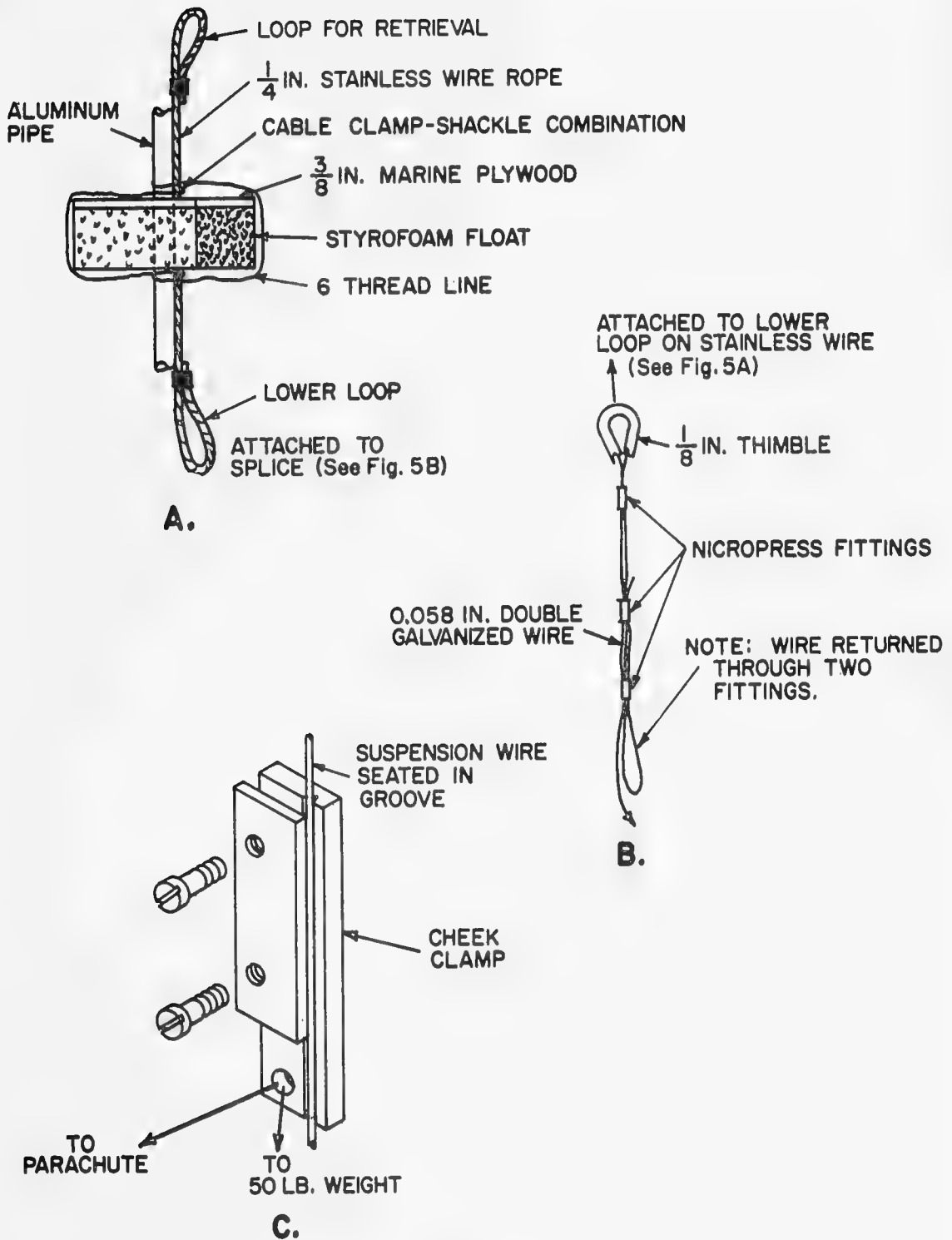
The bamboo pole was fastened to the upper end of the aluminum pole with hose clamps. Two flags, a wire mesh radar reflector, and a blinking light were attached to this pole as shown in Figure 4. The upper flag, used for locating the drogue, was about 1.0 by 1.5 meters, and international (day-glo) orange in color. The lower flag, used to identify the individual drogues, was a standard Navy type signal flag. The blinking light was fabricated using a socket, flashing light bulb (GE type 407), lamp cord and 6-volt hand lantern-type battery. The lights normally gave no trouble, but occasionally they stopped flashing after a day or two of operation because of breakdown of the bimetallic strip in the bulb. Batteries and bulbs were replaced at the termination of each transect. The longest period of operation was approximately 4 days.

A harness of 1/4-inch, stainless, 7x19 wire rope was run through the center hole in the float alongside the aluminum pole. A loop was fashioned at each end, and the wire rope was attached to the ballast weight below the float and to the aluminum pole above the plywood cover (see Figures 4 and 5A). The upper loop was used in retrieving the floats, and the parachute suspension wire was attached to the lower loop by means of a splice-type fitting as shown in Figure 5B. Any strain on the harness was transferred to the float by a 1/4-inch cable-clamp and a 1/4-inch shackle resting on the 3/8-inch marine plywood cover above the mast hole.



The Parachute Drogue Design

FIGURE 4



Techniques for Securing Suspension Wire

FIGURE 5

After the surface float was launched, the specified amount of wire was payed-out through an indicating meter wheel while the vessel steamed slowly up wind. When the proper amount of wire was payed-out, the cheek clamp (Figure 5C) was attached to the suspension wire. The parachute and a 50-pound weight were also secured to the cheek clamp (see Figure 4) and the suspension wire was cut. The weight was then lowered over the side until the parachute shrouds carried the full weight. At this time the weight was released and the parachute was pulled downward by the weight. (The parachute is payed-out in the reverse manner to that of a parachute in the air i.e., the shrouds are payed out first, the canopy being the last to enter the water.) In all cases, it was possible to see the parachute open under water.

All of the drogues used during this program were identical in construction.

NAVIGATION AND TRACKING

The positions of the surface-floats relative to known landmarks were determined with the Decca Hi-Fix System (Decca Navigator System, Ltd., London), and an auxiliary fix was taken with navigation radar.

The H.J.W. FAY was equipped with a Decca 404 navigation radar which was specified to have a frequency of 9320-9480 mc/s and a display discrimination of 20 yards. On shorter range scales (range scales in nautical miles are 0.75, 1.5, 3, 6, 12, 24, 48), the range ring accuracy is $1\frac{1}{2}$ percent of the maximum of the range used or 75 yards, whichever is the greater. The variable range marker accuracy is better than 1 percent of the range ring accuracy. The bearing resolution is $\pm 1^\circ$ (Ref.2). The OCEAN PEARL was equipped with a Decca 303 Navigation Radar which has characteristics similar to the Decca 404 aboard the H.J.W. FAY. The ranges most used were 6, 12, and 24 nautical miles. The Decca Hi-Fix is a high precision, lightweight, electronic position-fixing system, intended primarily for use at short ranges. The system is designed for hydrographic, geophysical, and other surveys in which an accuracy of less than one meter is required, and which demand the use of an electronic surveying system that is readily portable, simple to operate, and quick to install. Decca Hi-Fix receivers were temporarily installed on both vessels, and were used independently but in conjunction with the radars. The principle of the Hi-Fix can be described in the following manner. A set of stationary, standing electromagnetic, wave patterns are generated by radio transmitting stations. These patterns form coordinates in terms of which a radio receiver (carried by the user) provides continuous indication of its position with respect to the transmitting stations. If the positions of the stations are known, the signal received by the receiver may be converted into geographical coordinates by reference to a transformation chart. Computers can also be used for this conversion. (Ref.3).

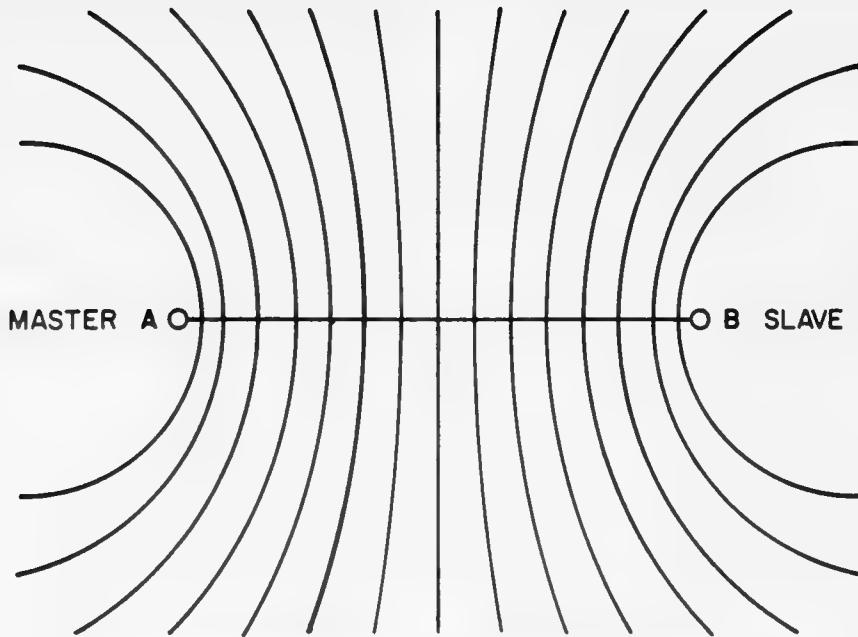
The Decca Hi-Fix "net" in the Tongue of the Ocean, shown on Figure 3, consists of three land based transmitting stations. (Two slave stations in conjunction with the common master station.) A single pair of stations produces a pattern which, being dependent on the distance AB (Figure 6A) and on the frequency used, can occupy calculable and highly stable positions on the earth's surface. Therefore, from the point of view of an observer carrying a phase comparison device (Receiver), the pattern constitutes a set of navigational position lines taking the form of a family of hyperbolae focussed on the two transmitters.

To enable the observer to fix his geographical position with reference to the ground stations, two sets of position lines are required. These are provided by a second hyperbolic pattern generated by Station C (Figure 6B) in conjunction with the common Master Station A. The receiving (phase-comparison) apparatus is duplicated to work with the two sets of coordinates, and the observer fixes his position at any instant by transferring the readings of the two phase meters to a map on which numbered lanes of the two patterns are printed.

Typical operating distances between Hi-Fix transmitters and receivers are between 5 and 35 miles, but the receiver can be used close to the transmitting station without loss of accuracy, or at a maximum offshore range of about 100 miles, if the radiated power from the stations is increased. The radiated power of the transmitting stations in TOTO is sufficient to ensure a working range normally in excess of 50 miles over seawater. During this program, Hi-Fix was used at a distance of approximately 110 nautical miles (Transect 1, Figure 3) from the farthest slave station with fair reliability. From a nomogram it was calculated that the lane width along Transect 1 was from 1700 to 1900 meters. Since the receivers are capable of reading to 1/100 of a lane, this provides an accuracy in the order of 17 - 19 meters.

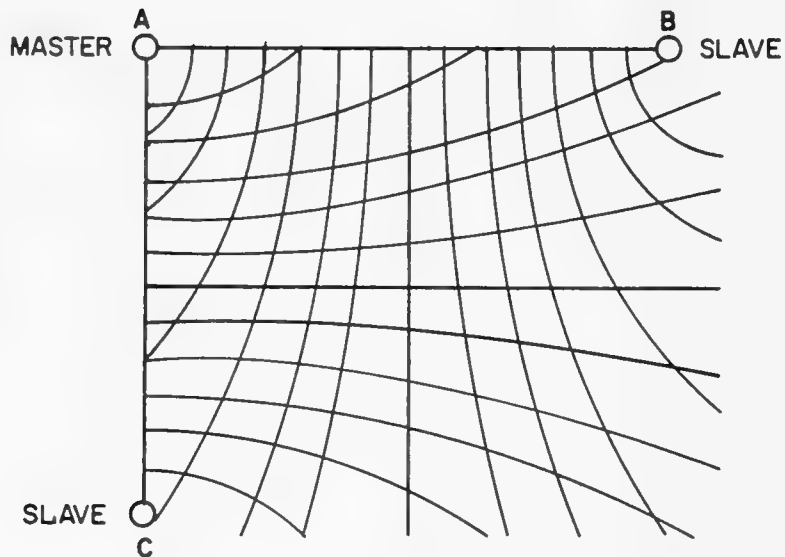
A series of Decca transformation charts were available for the TOTO area to plot the positions of the drogue floats between $23^{\circ} 50'$ and $24^{\circ} 50'$ north latitude. Although there was no chart coverage for the transect in the Northeast Providence Channel, the Naval Oceanographic Office has a computer program for converting Decca coordinates to latitude and longitude, and this was used to plot the positions of the floats in these areas.

In general, the Decca Hi-Fix System, backed up by radar, was quite adequate for tracking the drogues, and the position fixes obtained were satisfactory.



A Set of Hyperbolic Position Lines Generated by Synchronized Transmissions from Stations A and B

FIGURE 6A



Hyperbolic Grid Generated by Slave Stations B and C Locked to Master Station A

FIGURE 6B

REFERENCES

1. Volkmann, Gordon, John Knauss, & Allyn Vine, 1956: The Use of Parachute Drogues in the measurement of subsurface ocean currents. Trans. Amer. Geophys. Union, 37, 573 - 77.
2. Marine Acoustical Services, Inc., Vessel and Technical Services for Research in Underwater Acoustics and Oceanography. 1962. Copy No. 832 pp. F-2,3.
3. The Decca Navigator System as an aid to Survey. (Issue 5) The Decca Navigator Company, Limited, London, England.

APPENDIX A

The raw data for determining the velocity of the water currents along various transects in the Northeast Providence Channel and sections of TOTO, Bahamas, obtained by tracking parachute drogues in these areas during February and March 1963, are presented in tabular form.

TRANSECT 1

DROGUE Z		Depth: 1500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
14 Feb	1514	025	36	34.545	076	57	12.104	1
	1541	025	37	48.589	076	57	40.398	2
	2016	025	37	18.784	076	56	52.433	3
	2325	025	36	32.569	076	56	28.361	4
15 Feb	0047	025	40	25.137	077	03	32.717	5
	0530	025	42	41.178	076	51	00.705	6
	0921	025	36	37.590	076	54	50.204	7
	1332	025	36	48.824	076	54	24.774	8
	1522	025	36	58.051	076	54	05.828	9
	1725	025	36	58.051	076	54	05.828	10
	1945	025	36	45.202	076	54	10.618	11
	2324	025	37	42.810	076	53	39.176	12
16 Feb	0354	025	38	17.787	076	53	29.569	13
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TRANSECT 1

DROGUE Y		Depth: 1500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
14 Feb	1614	025	39	14.880	077	00	05.956	15
	1643	025	39	50.516	077	00	47.433	16
	2047	025	39	18.994	077	00	32.300	17
	2212	025	38	37.326	077	00	34.570	18
15 Feb	0123	025	37	43.846	076	59	46.420	19
	0505	025	42	10.681	076	55	11.933	20
	1300	025	34	29.279	076	57	01.524	21
	1948	025	29	15.662	076	59	06.569	22
	2235	025	32	20.237	076	56	27.274	23
16 Feb	0228	025	32	11.452	076	56	08.606	24
	1135	025	30	13.009	076	56	50.097	25
	1238	025	30	40.323	076	56	24.464	26
	1633	025	29	19.759	076	56	56.192	27
	1922	025	28	36.859	076	57	04.551	28

TRANSECT 1

DROGUE X		Depth: 1500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
14 Feb	1706	025	41	49.436	077	02	56.716	29
	1729	025	42	48.108	077	03	34.653	30
	2108	025	40	59.870	077	05	02.483	31
15 Feb	0323	025	36	20.909	076	55	47.101	32
	0435	025	45	17.404	076	59	10.551	33
	1225	025	37	01.053	076	59	41.084	34
	1902	025	35	25.956	076	57	49.943	35
	2007	025	35	19.921	076	57	35.504	36
	2036	025	34	57.723	076	57	44.332	37
	2215	025	34	23.997	076	57	38.249	38
16 Feb	0210	025	33	14.417	076	57	38.881	39
	1127	025	30	01.665	076	57	53.403	40
	1247	025	29	47.767	076	57	52.037	41
	1937	025	27	54.601	076	58	17.947	42
18 Feb	1010	025	21	39.100	076	59	23.697	43

TRANSECT 1

DROGUE V		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
14 Feb	1752	025	39	45.888	077	00	07.567	44
	1759	025	39	57.824	076	59	52.543	45
	1902	025	39	28.021	076	58	54.233	46
	2002	025	39	47.223	076	57	33.624	47
	2243	025	40	11.841	076	55	30.440	48
15 Feb	0212	026	29	01.026	076	25	33.578	49
	1040	025	47	14.176	076	58	33.524	50
	1545	025	44	41.529	077	03	23.830	51
16 Feb	1413	025	37	43.303	077	05	26.295	52
	1707	025	34	56.920	077	07	08.673	53
	2345	025	28	13.845	077	03	15.141	54
18 Feb	1450	025	25	09.126	077	06	31.361	55

TRANSECT 1

DROGUE 4		Depth: 600 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
15 Feb	1240	025	37	35.175	076	57	09.339	56
	1251	025	38	14.335	076	57	20.530	57
	1659	025	38	47.615	076	57	06.974	58
	1808	025	38	37.009	076	57	17.640	59
	2044	025	38	58.852	076	57	25.667	60
16 Feb	0001	025	40	10.407	076	57	13.186	61
	0435	025	39	46.747	076	58	22.001	62
	1447	025	40	23.882	077	02	02.144	63

TRANSECT 1

DROGUE 3		Depth: 200 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
15 Feb	1326	025	39	06.487	076	57	44.338	64
	1335	025	39	06.207	076	58	00.196	65
	1643	025	39	27.943	076	59	07.146	66
	1825	025	39	14.121	077	00	10.366	67
	2109	025	39	03.122	077	01	39.618	68
	2120	025	38	44.939	077	01	53.962	69
	2203	025	32	10.297	077	03	32.944	70
	--	--	--	--	--	--	--	71
	--	--	--	--	--	--	--	72
	16 Feb	0100	025	36	47.370	077	03	21.209
1040		025	32	57.914	077	03	00.147	74
1328		025	32	29.676	077	02	43.432	75
1546		025	33	12.958	077	02	08.768	76
1740		025	33	17.438	077	02	15.003	77
2247		025	33	04.097	077	03	38.255	78
18 Feb		1425	025	26	10.554	077	06	10.357
	2240	025	32	32.038	077	03	13,130	80

TRANSECT 1

DROGUE 8		Depth: 600 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
15 Feb	1445	025	44	41.094	077	03	39.060	81
	1500	025	44	47.062	077	04	14.062	82
	2152	025	47	05.926	077	04	59.827	83
	2355	025	51	27.783	077	02	32.461	84
16 Feb	0058	025	49	54.205	077	03	23.424	85
	0336	025	47	32.851	077	04	37.774	86
	0520	025	40	29.941	077	08	16.941	87
	0555	025	39	38.457	077	09	45.097	88
	0642	025	39	26.002	077	10	00.371	89
	0704	025	40	06.001	077	08	50.607	90
	0852	025	39	15.614	077	09	32.926	91
	1322	025	37	13.889	077	12	05.562	92
	1325	025	37	21.335	077	12	03.412	93
	1634	025	36	16.325	077	12	49.683	94
18 Feb	1315	025	23	15.512	077	13	19.429	95

TRANSECT 1

DROGUE 2		Depth: 200 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
15 Feb	1520	025	45	14.234	077	04	47.620	96
	1529	025	45	00.770	077	05	09.979	97
	2225	025	57	06.747	077	02	13.197	98
16 Feb	0016	025	46	32.219	077	06	11.888	99
	0146	025	44	46.356	077	06	48.046	100
	0253	025	43	52.368	077	06	47.881	101
	0421	025	36	05.484	077	09	59.286	102
	0610	025	34	13.071	077	10	17.605	103
	0754	025	32	54.600	077	10	13.565	104
	1146	025	29	34.195	077	09	09.775	105
	1218	025	28	13.059	077	10	06.484	106
	1456	025	25	42.017	077	08	42.794	107
	1146	025	28	44.929	077	10	19.245	108

TRANSECT 2

DROGUE 1		Depth: 1500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1139	025	25	41.381	077	37	43.500	109
	1202	025	27	02.523	077	36	55.725	110
	1730	025	26	38.028	077	37	19.601	111
	1920	025	26	37.742	077	37	31.019	112
	2308	025	26	50.215	077	37	38.423	113
22 Feb	0224	025	26	57.220	077	37	52.291	114
	0421	025	27	04.031	077	38	00.441	115
	0941	025	09	12.679	077	38	01.687	116
	1617	025	27	50.913	077	39	14.049	117
23 Feb	0041	025	25	24.826	077	40	09.166	118
	1047	025	28	25.708	077	42	18.513	119
	1731	025	32	25.489	077	43	46.448	120
24 Feb	1005	025	42	15.107	077	45	34.645	121

TRANSECT 2

DROGUE G		Depth: 600 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1244	025	25	15.645	077	35	58.600	122
	1255	025	25	02.531	077	35	41.829	123
	1803	025	24	37.049	077	36	06.816	124
	1905	025	24	26.790	077	36	11.542	125
	1940	025	24	26.877	077	36	18.279	126
	2340	025	24	33.300	077	36	30.474	127
22 Feb	0258	025	24	35.814	077	36	35.243	128
	0443	025	23	46.431	077	36	43.101	129
	0905	025	25	16.402	077	37	00.984	130
	1028	025	25	20.927	077	37	01.727	131
	1645	025	25	00.208	077	37	06.350	132
23 Feb	0009	025	23	45.948	077	37	39.076	133
	1003	025	21	50.970	077	38	51.956	134
	1658	025	21	28.333	077	39	21.021	135
24 Feb	1135	025	19	27.225	077	40	40.981	136
25 Feb	1600	025	13	03.541	077	35	04.130	137

TRANSECT 2

DROGUE M		Depth: 200 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1310	025	24	05.536	077	35	02.869	138
	1814	025	23	11.030	077	34	47.129	139
	1854	025	22	45.258	077	34	47.678	140
	1953	025	22	51.185	077	34	43.736	141
22 Feb	0008	026	05	16.360	077	32	08.354	142
	0332	025	21	06.656	077	35	22.117	143
	0512	025	20	50.212	077	35	46.368	144
	0828	025	21	17.870	077	36	25.281	145
	1113	025	21	02.616	077	36	53.108	146
	1710	025	20	48.945	077	37	31.628	147
	2335	025	19	20.172	077	38	01.215	148
23 Feb	0207	025	18	59.986	077	38	24.942	149
	1144	025	17	48.451	077	41	10.040	150
	1908	025	29	16.129	077	44	42.443	151
24 Feb	1212	024	18	39.796	077	39	33.110	152
25 Feb	1254	024	39	02.206	077	41	39.802	153

TRANSECT 2

DROGUE F		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1327	025	22	50.604	077	34	25.384	154
	1338	025	22	50.758	077	34	28.538	155
22 Feb	1253	025	24	41.374	077	37	45.781	156
	1632	025	25	24.094	077	39	05.940	157
23 Feb	0032	025	26	35.331	077	40	11.466	158
	1039	025	29	57.434	077	42	20.892	159
	1743	025	34	18.772	077	43	55.488	160
24 Feb	0905	025	30	03.943	077	37	32.382	161

TRANSECT 2

DROGUE R		Depth: 200 Meters							
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.	
		deg	min	sec	deg	min	sec		
21 Feb	1229	025	17	52.241	077	29	44.114	162	
	1237	025	18	01.761	077	29	49.514	163	
	1400	025	17	37.874	077	30	10.976	164	
	1423	025	17	44.689	077	30	14.587	165	
	1526	025	17	58.344	077	30	26.163	166	
	1658	025	17	40.156	077	30	46.041	167	
	1830	025	17	39.365	077	31	01.737	168	
	1946	025	17	56.601	077	31	10.652	169	
	2029	025	17	48.600	077	31	19.995	170	
	2248	025	18	08.917	077	31	34.911	171	
22 Feb	0019	025	18	05.083	077	31	38.495	172	
	0042	025	17	52.027	077	31	42.183	173	
	0121	025	17	56.454	077	31	41.317	174	
	0251	025	17	45.248	077	31	52.561	175	
	0549	025	17	20.805	077	32	42.249	176	
	0754	025	17	13.649	077	33	12.258	177	
	0842	025	17	48.816	077	33	21.344	178	
	1112	025	17	44.585	077	33	45.524	179	
	1240	025	17	53.768	077	33	53.225	180	
	1737	025	17	00.237	077	34	27.290	181	
	2253	025	15	52.556	077	34	30.958	182	
	23 Feb	0250	025	14	54.317	077	34	58.983	183
		0545	025	14	32.449	077	35	36.745	184
1233		025	13	12.939	077	38	12.566	185	
1740		025	13	12.505	077	39	39.216	186	
25 Feb	1230	025	33	19.869	077	43	52.586	187	

TRANSECT 2

DROGUE T		Depth: 600 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1138	025	15	34.882	077	29	05.987	188
	1153	025	16	15.880	077	29	18.025	189
	1415	025	16	02.504	077	29	14.437	190
	1432	025	15	56.985	077	29	13.540	191
	1509	025	15	58.732	077	29	10.302	192
	1639	025	15	49.559	077	29	10.844	193
	1722	025	15	42.993	077	29	12.098	194
	1805	025	15	46.123	077	29	11.740	195
	1859	025	15	30.862	077	29	12.979	196
	1921	025	15	33.653	077	29	13.163	197
	2016	025	15	17.632	077	29	15.993	198
	2045	025	15	18.255	077	29	14.920	199
	--	--	--	--	--	--	--	200
	2145	025	15	15.200	077	29	15.269	201
	2218	025	15	03.065	077	29	16.654	202
	2328	025	15	03.875	077	29	20.056	203
22 Feb	0010	025	14	52.900	077	29	24.288	204
	0147	025	14	42.996	077	29	36.357	205
	0222	025	15	13.552	077	29	33.517	206
	0323	025	15	08.358	077	29	43.139	207
	0625	025	15	03.811	077	29	57.745	208
	0711	025	15	01.684	077	29	55.944	209
	0728	025	15	00.331	077	29	58.609	210
	0758	025	15	01.956	077	29	55.411	211
	0933	025	15	17.770	077	29	48.200	212
	1017	025	15	16.761	077	29	44.262	213
	1418	025	15	08.099	077	29	22.580	214
	1815	025	14	34.196	077	29	10.065	215
	2017	025	14	17.690	077	28	59.247	216
23 Feb	0346	025	14	02.056	077	23	12.194	217
	0737	025	14	07.226	077	28	15.434	218
	1454	025	14	37.995	077	27	17.384	219
24 Feb	1428	025	16	49.965	077	27	01.416	220
25 Feb	1028	025	16	56.013	077	27	14.962	221

TRANSECT 2

DROGUE SR		Depth: 1500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1047	025	13	41.815	077	28	15.463	222
	1112	025	15	02.052	077	28	43.524	223
	1450	025	04	21.116	077	30	03.196	224
	1454	025	14	45.668	077	28	44.558	225
	1632	025	14	59.883	077	28	38.860	226
	1728	025	15	13.856	077	28	37.616	227
	1800	025	15	10.975	077	28	37.974	228
	1903	025	15	17.095	077	28	36.718	229
	1917	025	15	10.975	077	28	37.974	230
	2024	025	15	35.808	077	28	28.425	231
	2037	025	15	33.599	077	28	27.711	232
	2110	025	15	32.816	077	28	24.834	233
	2154	025	15	54.480	077	28	16.104	234
	2209	025	15	45.395	077	28	17.769	235
	2351	025	16	10.292	077	28	04.088	236
22 Feb	0205	025	16	00.105	077	27	59.466	237
	0345	025	16	05.155	077	27	55.815	238
	0701	025	16	15.990	077	27	55.363	239
	0738	025	16	21.101	077	27	55.678	240
	0955	025	16	57.376	077	27	49.844	241
	1416	025	17	34.552	077	27	30.174	242
	2046	025	17	56.819	077	27	07.817	243
23 Feb	0432	025	18	20.439	077	26	15.322	244
	0827	025	18	49.465	077	26	07.285	245
	1538	025	19	50.848	077	26	25.112	246
24 Feb	1532	025	24	23.582	077	29	44.770	247
25 Feb	1130	025	26	01.982	077	31	52.918	248

TRANSECT 2

DROGUE 3 II		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
21 Feb	1601	025	15	30.480	077	26	44.027	249
	1741	025	15	33.604	077	27	06.764	250
	1910	025	15	10.310	077	27	34.883	251
	2030	025	15	05.935	077	27	53.972	252
	2116	025	15	09.834	077	28	02.232	253
	2203	025	15	07.748	077	28	12.300	254
	2340	025	15	15.266	077	28	35.462	255
22 Feb	0005	025	15	02.404	077	28	42.987	256
	0150	025	14	30.120	077	29	16.462	257
	0220	025	14	40.504	077	29	21.709	258
	0325	025	14	37.492	077	29	40.947	259
	0635	025	13	57.205	077	30	53.143	260
	0811	025	13	33.048	077	31	28.576	261
	0915	025	13	35.956	077	31	50.756	262
	1036	025	13	30.220	077	32	15.291	263
	1145	025	13	13.048	077	32	30.336	264
	1306	025	13	11.553	077	32	42.827	265
2158	025	11	10.283	077	34	35.992	266	
23 Feb	0630	025	08	19.405	077	38	40.748	267
	1600	024	18	39.625	077	39	33.696	268

TRANSECT 3

DROGUE R II		Depth: 200 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1137	024	43	16.622	077	32	01.567	527
	1659	024	42	25.968	077	31	11.111	528
	1849	024	42	03.519	077	30	44.143	529
	1923	024	42	05.929	077	30	35.460	530
	2006	024	41	39.903	077	30	27.913	531
	2226	024	41	04.949	077	30	21.656	532
1 Mar	0054	024	40	35.675	077	30	18.935	533
	0607	024	39	20.771	077	28	50.592	534
	0806	024	38	48.578	077	27	44.756	535
	1156	024	38	14.558	077	28	00.276	536
	1541	024	38	27.183	077	28	10.640	537
2 Mar	1012	024	39	42.072	077	27	42.327	538
	1345	024	40	48.859	077	27	57.604	539
	1715	024	42	17.975	077	28	15.535	540
3 Mar	1004	024	47	21.115	077	30	57.884	541
	1615	024	48	41.344	077	32	07.071	542
5 Mar	1310	024	50	56.763	077	37	23.614	543

TRANSECT 3

DROGUE 3 III		Depth: 1500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1356	024	44	17.713	077	31	24.139	544
	1409	024	43	50.314	077	31	33.520	545
	1647	024	43	31.086	077	31	27.657	546
	1902	024	43	07.036	077	31	35.730	547
	2022	024	42	49.172	077	31	43.352	548
	2300	024	42	23.140	077	31	47.981	549
1 Mar	0012	024	42	11.092	077	31	54.942	550
	0119	024	41	57.218	077	32	06.165	551
	0446	024	42	12.330	077	32	33.015	552
	0914	024	42	22.475	077	33	01.288	553
	1322	024	42	38.952	077	33	26.400	554
	1721	024	43	18.072	077	34	11.326	555
2 Mar	0834	024	45	37.510	077	35	43.282	556
	1227	024	46	00.941	077	36	08.634	557
	1630	024	46	54.555	077	36	45.816	558
3 Mar	0715	024	48	20.440	077	38	30.949	559
	0743	024	48	21.115	077	38	33.589	560
	0746	022	06	03.363	077	35	21.174	561

TRANSECT 3

DROGUE T II		Depth: 1000 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1041	024	44	02.391	077	32	04.572	562
	1101	024	43	16.718	077	31	45.436	563
	1649	024	43	33.408	077	31	18.946	564
	1906	024	43	30.747	077	31	23.069	565
	2050	024	43	22.768	077	31	28.634	566
	2251	024	43	18.697	077	31	35.123	567
1 Mar	0022	024	43	16.174	077	31	46.921	568
	0150	024	43	15.439	077	31	52.399	569
	0500	024	43	39.509	077	32	14.702	570
	0933	024	44	05.764	077	32	25.260	571
	1257	024	44	07.078	077	32	25.814	572
	1638	024	44	24.904	077	32	35.783	573
2 Mar	0809	024	44	07.339	077	33	01.222	574
	1159	024	43	45.393	077	32	45.619	575
	1540	024	43	26.463	077	32	32.869	576
	1713	024	43	21.309	077	32	42.703	577
3 Mar	1045	024	41	58.382	077	33	01.131	578

TRANSECT 3

DROGUE S.R. II		Depth: 1000 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1740	024	40	53.653	077	36	54.879	579
	1805	024	41	05.929	077	36	17.519	580
	2345	024	40	37.220	077	36	22.366	581
1 Mar	0357	024	40	45.195	077	36	49.234	582
	1400	024	40	08.983	077	36	48.645	583
	1755	024	40	15.833	077	37	07.621	584
2 Mar	1112	024	38	02.849	077	36	47.209	585
	1453	024	37	28.871	077	36	34.118	586
	1906	024	37	25.077	077	36	18.511	587
3 Mar	1140	024	35	32.005	077	36	20.718	588

TRANSECT 4

DROGUE C		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1319	024	21	13.142	077	35	13.130	400
	1349	024	21	27.488	077	35	15.423	401
	1417	024	21	43.624	077	35	15.769	402
	1445	024	21	53.568	077	35	22.299	403
	1513	024	22	08.587	077	35	21.290	404
	1538	024	22	19.865	077	35	24.862	405
	--	024	22	32.338	077	35	28.881	406
	1635	024	22	48.214	077	35	32.349	407
	1708	024	23	05.767	077	35	36.923	408
	1741	024	23	22.726	077	35	40.607	409
	1812	024	23	38.015	077	35	44.732	410
	1839	024	23	51.735	077	35	48.867	411
	1909	024	24	05.482	077	35	52.779	412
	1939	024	24	19.013	077	35	57.798	413
	2008	024	24	30.567	077	36	01.535	414
	2038	024	24	43.149	077	36	05.693	415
	2104	024	24	50.607	077	36	09.545	416
	--	--	--	--	--	--	--	417
	2200	024	25	04.407	077	36	16.128	418
	2233	024	25	10.588	077	36	17.995	419
2301	024	25	15.371	077	36	20.114	420	
2332	024	25	20.110	077	36	22.398	421	
1 Mar	0005	024	25	24.983	077	36	25.880	422
	0042	024	25	28.016	077	36	29.974	423
	0120	024	25	32.262	077	36	34.669	424
	0158	024	25	34.967	077	36	37.985	425
	0247	024	25	37.581	077	36	45.122	426
	0345	024	25	37.937	077	36	56.771	427
	0447	024	25	29.532	077	37	09.024	428
	0546	024	25	34.379	077	37	22.208	429
	0656	024	25	30.768	077	37	33.641	430
	0805	024	25	28.563	077	37	45.675	431
	0920	024	25	26.798	077	37	59.218	432
	1042	024	25	26.531	077	38	15.924	433
	1159	024	25	24.344	077	38	31.531	434
	1530	024	22	06.680	077	35	22.012	435

TRANSECT 4

DROGUE K		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1146	024	22	14.766	077	36	28.278	269
	1216	024	22	25.329	077	36	32.380	270
	1241	024	22	33.924	077	36	35.780	271
	1336	024	22	52.111	077	36	42.504	272
	1404	024	23	02.052	077	36	47.260	273
	1432	024	23	11.285	077	36	50.882	274
	1500	024	23	20.135	077	36	54.650	275
	1526	024	23	28.489	077	36	58.197	276
	1552	024	23	36.786	077	37	02.340	277
	1622	024	23	45.937	077	37	06.174	278
	1649	024	23	55.174	077	37	10.247	279
	1725	024	24	04.939	077	37	13.336	280
	1754	024	24	13.534	077	37	16.598	281
	1824	024	24	20.417	077	37	20.970	282
	1852	024	24	27.700	077	37	24.760	283
	1924	024	24	29.225	077	37	29.679	284
	1953	024	24	29.778	077	37	32.289	285
	2024	024	24	28.666	077	37	34.745	286
	2050	024	24	27.253	077	37	38.213	287
	--	--	--	--	--	--	--	288
	2145	024	24	24.050	077	37	43.966	289
	2217	024	24	21.031	077	37	46.808	290
	2245	024	24	17.941	077	37	48.742	291
	2316	024	24	13.787	077	37	50.783	292
2347	024	24	08.513	077	37	52.923	293	
1 Mar	0022	024	24	02.202	077	37	56.385	294
	0100	024	23	56.272	077	37	56.804	295
	0138	024	23	49.090	077	37	59.203	296
	0222	024	23	41.384	077	38	03.552	297
	0318	024	23	28.734	077	38	06.235	298
	0413	024	23	12.997	077	38	08.284	299
	0515	024	22	50.352	077	38	07.298	300
	0525	024	22	38.339	077	38	04.011	301
	0731	024	22	27.269	077	38	03.525	302
	0843	024	22	11.941	077	38	00.307	303
	1000	024	22	00.228	077	37	59.590	304
	1119	024	21	46.941	077	37	59.972	305
1245	024	21	33.265	077	38	00.383	306	

TRANSECT 4

DROGUE K (continued)		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
2 Mar	0812	024	20	50.463	077	35	05.798	307
	--	--	--	--	--	--	--	308
	1230	024	22	43.301	077	35	57.511	309
	1400	024	23	13.371	077	36	10.716	310
	1515	024	23	42.050	077	36	21.976	311
	1628	024	24	02.986	077	36	29.721	312
	1822	024	24	24.537	077	36	47.332	313
	1932	024	24	33.338	077	37	01.026	314
	2053	024	24	44.000	077	37	22.221	315
	2217	024	24	59.634	077	37	46.989	316
	2350	024	25	20.159	077	38	19.681	317
3 Mar	0134	024	25	33.183	077	38	44.664	318
	0322	024	25	43.282	077	39	02.219	319
	0514	024	25	51.866	077	39	12.222	320
	0726	024	26	01.029	077	39	23.459	321
	1033	024	26	35.344	077	39	52.446	322

TRANSECT 4

DROGUE Y II		Depth: 10 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	1205	024	21	18.687	077	35	42.808	323
	1230	024	21	29.065	077	35	43.974	324
	1254	024	21	40.812	077	35	45.461	325
	1327	024	21	54.530	077	35	47.781	326
	1343	024	22	05.208	077	35	46.858	327
	1355	024	22	07.838	077	35	49.164	328
	1412	024	22	15.459	077	35	50.407	329
	1424	024	22	21.518	077	35	51.301	330
	1440	024	22	28.389	077	35	52.544	331
	1452	024	22	31.967	077	35	53.780	332
	1508	024	22	40.616	077	35	54.723	333
	1517	024	22	46.801	077	36	02.673	334
	1534	024	22	52.398	077	35	56.720	335
	1545	024	22	57.094	077	35	57.158	336
	1600	024	23	03.496	077	35	58.442	337
	1615	024	23	09.496	077	36	00.310	338
	1630	024	23	17.637	077	36	01.228	339
	1641	024	23	23.133	077	36	00.524	340
	1700	024	23	30.548	077	36	03.008	341
	1714	024	23	38.077	077	36	03.124	342
	1736	024	23	47.336	077	36	04.820	343
	1747	024	23	52.080	077	36	05.322	344
	1806	024	24	01.370	077	36	07.254	345
	1815	024	24	05.579	077	36	08.053	346
	1836	024	24	14.618	077	36	10.539	347
	1844	024	24	17.833	077	36	10.434	348
	1904	024	24	24.633	077	36	14.241	349
	1913	024	24	28.652	077	36	15.454	350
	1936	024	24	33.809	077	36	18.985	351
	1944	024	24	36.014	077	36	19.798	352
	2004	024	24	40.412	077	36	22.519	353
	2013	024	24	40.806	077	36	24.204	354
	2033	024	24	45.548	077	36	27.173	355
	2042	024	24	44.140	077	36	27.357	356
	2101	024	24	49.656	--	--	--	357
	2108	--	--	--	077	36	31.557	358
	2128	024	24	52.523	077	36	35.269	359
	2135	024	24	51.163	077	36	35.726	360

TRANSECT 4

DROGUE Y II (continued)					Depth: 10 Meters			
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
28 Feb	2157	024	24	53.947	077	36	38.755	361
	2205	024	24	53.085	077	36	39.662	362
	2228	024	24	56.348	077	36	42.390	363
	2236	024	24	55.338	077	36	42.493	364
	2256	024	24	58.312	077	36	45.919	365
	2306	024	24	56.987	077	36	45.424	366
	2327	024	24	59.726	077	36	48.395	367
	2338	024	24	55.141	077	36	49.023	368
	2359	024	24	58.558	077	36	52.068	369
	1 Mar	0012	024	24	58.250	077	36	51.674
0037		024	25	00.353	077	36	56.050	371
0048		024	24	59.598	077	36	55.472	372
0115		024	24	59.643	077	37	02.101	373
0126		024	24	58.971	077	37	01.072	374
0152		024	24	58.883	077	37	07.784	375
0218		024	24	57.456	077	37	07.002	376
0240		024	24	59.203	077	37	12.258	377
0300		024	24	57.161	077	37	16.117	378
0337		024	24	54.766	077	37	19.888	379
0354		024	24	53.025	077	37	20.629	380
0435		024	24	48.438	077	37	29.637	381
0457		024	24	47.845	077	37	35.905	382
0536		024	24	44.024	077	37	42.526	383
0556		024	24	42.595	077	37	49.550	384
0645		024	24	34.352	077	37	54.925	385
0240		024	24	56.274	077	37	12.415	386
0708		024	24	31.070	077	37	58.318	387
0750		024	24	27.286	077	38	06.280	388
0819		024	24	24.959	077	38	11.820	389
0908		024	24	18.957	077	38	23.154	390
0932		024	24	15.588	077	38	27.156	391
1024		024	24	10.774	077	38	36.696	392
1048	024	24	06.867	077	38	41.281	393	
1145	024	24	01.651	077	38	49.742	394	
1223	024	23	57.593	077	38	57.838	395	
2 Mar	1142	024	24	03.433	077	40	11.401	396
	1154	024	26	28.624	077	40	52.236	397
	1142	024	23	47.007	077	40	06.945	398
	1154	024	23	44.617	077	40	06.083	399

TRANSECT 5

DROGUE P		Depth: 200 Meters							
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.	
		deg	min	sec	deg	min	sec		
2 Mar	0946	024	22	14.801	077	32	36.838	495	
	0951	024	22	15.425	077	32	49.872	496	
	1306	--	--	--	--	--	--	497	
	1341	024	23	23.313	077	33	11.550	498	
	1424	024	23	28.969	077	33	17.391	499	
	1457	024	23	33.272	077	33	24.761	500	
	1534	024	23	40.418	077	33	31.897	501	
	1611	024	23	36.043	077	32	25.860	502	
	1646	024	23	56.608	077	33	40.179	503	
	1705	024	24	15.640	077	33	48.925	504	
	1740	024	24	24.400	077	33	53.046	505	
	1956	024	24	46.861	077	33	57.375	506	
	2033	024	24	58.515	077	33	59.078	507	
	2115	024	25	09.624	077	34	02.339	508	
	2152	024	25	20.285	077	34	02.342	509	
	2238	024	25	32.667	077	34	05.310	510	
	2320	024	25	44.903	077	34	10.285	511	
	3 Mar	0025	024	26	01.132	077	34	14.983	512
		0108	024	26	14.705	077	34	20.598	513
		0210	024	26	33.230	077	34	28.949	514
0253		024	26	47.419	077	34	32.747	515	
0350		024	27	01.928	077	34	36.916	516	
0440		024	27	20.836	077	34	37.454	517	
0548		024	27	38.565	077	34	41.884	518	
0650		024	27	53.031	077	34	46.340	519	
0800		024	28	07.621	077	34	53.816	520	
1000		024	28	35.464	077	35	11.289	521	
1117		024	28	50.597	077	35	25.210	522	
1240		024	29	05.097	077	35	34.339	523	
1655		024	29	54.525	077	35	30.719	524	
2037		024	30	19.753	077	35	44.627	525	
5 Mar		1055	024	30	57.497	077	39	55.986	526

TRANSECT 5

DROGUE U		Depth: 500 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
2 Mar	0920	024	22	08.443	077	31	39.274	463
	0932	024	22	05.303	077	32	02.688	464
	1320	024	22	30.670	077	32	17.634	465
	1335	024	22	31.766	077	32	18.429	466
	1431	024	22	37.219	077	32	26.974	467
	1448	024	22	39.413	077	32	29.837	468
	1542	024	22	49.278	077	32	40.149	469
	1603	024	22	54.453	077	32	44.381	470
	1648	024	23	10.067	077	32	54.636	471
	1658	024	23	30.054	077	33	02.749	472
	1847	024	23	44.724	077	33	10.129	473
	1907	024	23	52.651	077	33	11.125	474
	2005	024	24	08.093	077	33	15.184	475
	2027	024	24	12.310	077	33	14.198	476
	2123	024	24	16.891	077	33	17.480	477
	2142	024	24	17.919	077	33	17.520	478
	2250	024	24	16.177	077	33	19.632	479
2308	024	24	16.646	077	33	17.987	480	
3 Mar	0040	024	24	11.411	077	33	20.563	481
	0054	024	24	12.186	077	33	19.830	482
	0226	024	24	16.249	077	33	17.677	483
	0235	024	24	18.255	077	33	16.652	484
	0406	024	24	26.595	077	33	17.948	485
	0417	024	24	29.278	077	33	18.614	486
	0613	024	24	48.601	077	33	23.253	487
	0624	024	24	51.141	077	33	24.019	488
	0830	024	25	11.156	077	33	29.481	489
	0935	024	25	15.969	077	33	31.466	490
	1221	024	25	10.590	077	33	32.558	491
	1734	024	25	09.606	077	34	35.615	492
	1816	024	25	17.289	077	34	47.397	493
	1950	024	25	29.180	077	35	12.031	494

TRANSECT 5

DROGUE N		Depth: 1000 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
2 Mar	0856	024	22	06.799	077	30	40.599	436
	0911	024	22	00.891	077	31	19.171	437
	1326	024	21	57.638	077	31	25.853	438
	1440	024	21	52.187	077	31	24.536	439
	1552	024	21	59.141	077	31	29.343	440
	1708	024	22	26.673	077	31	41.801	441
	1749	024	22	40.440	077	31	47.411	442
	1902	024	23	00.246	077	32	01.706	443
	2015	024	23	18.587	077	32	03.192	444
	2135	024	23	33.026	077	32	11.426	445
	2300	024	23	53.378	077	32	14.859	446
	3 Mar	0047	024	24	12.109	077	32	23.372
0230		024	24	32.837	077	32	35.513	448
0412		024	24	56.594	077	32	48.005	449
0618		024	25	27.197	077	33	05.249	450
0837		024	26	02.338	077	33	26.938	451
0927		024	26	13.378	077	33	35.359	452
1229		024	26	45.673	077	34	07.741	453
1718		024	27	37.346	077	35	04.590	454
2017		024	28	14.121	077	35	39.477	455
5 Mar		1126	024	32	37.749	077	40	47.905

TRANSECT 5

DROGUE L		Depth: 1400 Meters						
Date	Time (EST)	LATITUDE (N)			LONGITUDE (W)			Consecutive Fix. No.
		deg	min	sec	deg	min	sec	
3 Mar	0900	024	27	28.772	077	32	02.292	457
	0917	024	26	41.137	077	31	52.232	458
	1143	024	27	11.248	077	32	11.182	459
	1755	024	26	20.046	077	32	04.744	460
	1918	024	26	15.667	077	32	05.683	461
	5 Mar	1021	024	28	49.290	--	--	--

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LAGRANGIAN CURRENT MEASUREMENTS IN THE NORTHEAST PROVIDENCE CHANNEL AND THE TONGUE OF THE OCEAN, BAHAMAS, 14 FEBRUARY TO 6 MARCH 1963 - PRELIMINARY REPORT by G. S. Cook, 48 pp. September 1963.

UNCLASSIFIED

Since a knowledge of the environmental factors affecting deep water tracking at the Atlantic Undersea Test and Evaluation Center (AUTEC) is essential, a program was established to gather additional data on the water currents in the Northeast Providence Channel and selected areas in the Tongue of the Ocean, Bahamas.

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2. Deep Water Environment
3. Oceanography
4. The Tongue of the Ocean
5. Water Currents

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The water current measurements were made with parachute drogues. A total of 27 drogues (all identical in construction) were tracked, and over 500 position fixes were taken.

This is a preliminary report, only raw data and descriptions of the equipment and procedures are presented. A subsequent report will include a final analysis of the data in an attempt to answer pertinent questions regarding the water currents in the Tongue of the Ocean.

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4. The Tongue of the Ocean
5. Water Currents

I. Cook, G. S.

WEPTASK: RUTO-3E-000/219 1/SF-099-03-02 and ASW Ocen Res: RU22-2E-000/219 IR004-03-01

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Naval Underwater Ordnance Station, Newport, R. I.
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