FINAL REPORT

SOUTHEAST TURTLE SURVEY (SETS)

PELAGIC AERIAL SURVEYS V through VII

Including

TIME OF DAY / SEA STATE SPECIAL EXPERIMENT

INCLUSIVE DATES OF SURVEY REPORT: April 1983 - March 1984

CONTRACTOR: AERO-MARINE SURVEYS, INC.
GROTON-NEW LONDON AIRPORT
GROTON, CONNECTICUT 06340

In Partial Fulfillment Of

NATIONAL MARINE FISHERIES SERVICE

CONTRACT NUMBER: NMFS-SEFC NA83-GA-C-00017

DATE OF REPORT: 30 April 1984

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1 May 1984

Dr. Nancy Thompson
National Marine Fisheries Service
Southeast Fisheries Center
75 Virginia Beach Drive
Miami, Florida 33149

REF: Southeast Turtle Surveys, Submission of Final Report

Dear Nan:

With this letter I am enclosing one copy of our final report on the NMFS Southeast Turtle Survey (SETS) for the period April 1983 through March 1984. This includes the Time of Day / Sea State Special Experiment. This concludes our responsibilities for the initial period of our contract NMFS-SEFC NA83-GA-C-00017.

Please call me if there are any questions concerning the report. It has been a pleasure to work with you over the past year.

Sincerely yours,

Timothy L. Flynn

President

Encl

GENERAL AND PROJECT OBJECTIVES

Aero-Marine Surveys, Inc., has completed the second year of pelagic surveys for the Southeast Turtle Survey program (SETS). Three seasonal pelagic surveys were flown from Cape Hatteras, NC, to Key West, FL, and offshore to the approximate western edge of the Gulf Stream. In addition, one special survey measured the response of sightings to the variables (1) Time of Day, and (2) Sea State. The pelagic surveys were designed to provide data for sea turtle population estimates in the Southeast U.S., as well as information on spatial and temporal distribution, behavior, ecological correlates, and sightability.

This report presents an overview of the objectives, methods, calendar, innovations, and preliminary results of the pelagic portion of the SETS program from April 1983 to March 1984. A separate report with different authorship presents the summary of the nesting beach surveys. Although the contract was primarily for data collection, some preliminary data reduction and interpretation were performed and are presented herein.

INTRODUCTION

The pelagic aerial survey of sea turtles in the Southeast U.S. waters is the second comprehensive survey of turtles in this area. Such surveys have been completed in the Northeast under the Cetacean and Turtle Assessment Program (CETAP) and the Gulf of Mexico, both funded by the Burea of Land Management (BLM). There are five species of sea turtles which occur in this area; the loggerhead (Caretta caretta), leatherback (Dermochelys coriacea). Atlantic green (Chelonia mydas), hawksbill (Eretmochelys imbricata), and Kemp's ridley (Lepidochelys kempi). A survey plan was developed using line transect methods to sample these animals in the study area. Specifics follow on the study area, data collection methods, and preliminary results.

METHODS

SETS Pelagic Study Area

The study area extends from Cape Hatteras, NC, to Key West, FL, and offshore to the approximate western edge of the Gulf Stream, as shown on NOAA chart #11009. From Cape Canaveral, FL, to Key West, FL, the study area extends from shore out for 25 n.mi. In the southern end of the standard study area, the Gulf Stream is found in approximately 60% of Block 10, and approximately 40% of Block 9. The entire area is 29,086 n.mi^2, and is divided into ten contiguous sampling blocks of nearly equal area (2,900 n.mi^2). Figure 1 shows the study area and its blocks. Because of coastal assymetry and the variable offshore distance of the western edge of the Gulf Stream, each sampling block has a characteristic shape. South of Cape Canaveral, where the Gulf Stream is close to shore in Blocks 9 and 10, a 20 n.mi.-wide strip follows the coastal contour. To reduce the effects of glare, transects within a block were flown on a NW-SE axis. The borders of each

block are so oriented.

The coordinates of the sampling block borders are given in Figure 3. Under appropriate conditions, each block was flown during one day from one of the three bases of operation: Titusville, FL (Blocks 6-10); Charlestown, SC (Blocks 3-5); and Wilmington, NC (Blocks 1-2). The progression of blocks sampled depended upon weather, offshore military activity, and transit logistics.

The longest survey transects (Block 7) were approximately 82 n.mi. while the shortest transects (Block 1) were approximately 11 n.mi. The farthest point offshore was approximately 65 n.mi. During a standard survey, transects were randomly chosen at least 1 n.mi. apart and added to achieve the approximate coverage required.

Because of the curvature of the coastline, the NW-SE transects were approximately normal to depth contours, except in the southern areas characterized by shallow plateaus. No bays, harbors, nor estuaries were sampled along the coastline.

Methodology

1. Survey platform. The pelagic aerial survey used Aero-Marine-owned Beechraft AT-11's. This type of twin-engined aircraft allows an unobstructed view of the trackline for two observers sitting in the plexiglass nose bubble. Figure 4 illustrates the configuration of the AT-11. Aboard the survey aircraft were a Loran-C navigation computer (with way point memory capability) for instantaneous position data, a Barnes PRT-5S for sea surface temperature data, and a voice-actuated intercommunications system through which observations were

communicated to aft recording personnel. All OAS-required overwater safety equipment was carried on the aircraft. The aircraft and instruments are described in Appendix A of this report.

2. Calibration of observation bubble. As required in line transect sampling, each sighting from the observation bubble includes information on distance from the trackline. Rather than recording the angle of each sighting, the bubble was calibrated and marked in intervals to collect right angle or perpendicular distances from the trackline for each sighting. The assumption is made that all animals directly on the trackline are seen.

The bubble calibration procedures were described in the "Southeast Turtle Survey (SETS) Final Report"; National Marine Fisheries Service; Shoop, C.R., and Thompson, T.J.; 30 April 1983.

3. Flight Plans. The chief observer was responsible for submitting a new set of randomized transects and corresponding way points for each survey. Transects were taken from the available 1 n.mi. intervals along a line perpendicular to the direction of flight (315°T to 135°T) in each sampling block. Random numbers within each block range were used and transects added to meet the required coverage percentages (using 0.334 n.mi. as the effective swath width). Upon completion of the flight, the chief observer calculated actual coverage, reviewed formats, and summarized data.

4. Observation Methods. The observer team was chosen from qualified personnel, all having aerial survey experience and all being well-acquainted with sea turtle morphology and biology. (See personnel section, Appendix B.) Each observer was

trained in the elements of line ytransect methodology and was instructed to maintain body posture, to keep visual horizon reference, to report accurate sighting intervals, and to identify species conservatively, assigning reliability codes to each identification. Since observers also recorded data, each was familiar with maintaining notes on environmental conditions. A standard rotation of four observers was followed to reduce observer fatigue. Generally, observer rotation was made for each transect. Position 1 was the right observer (looking left); position 2 was the left observer (looking right); position 3 was the rest station; and position 4 was the data entry and recording station. In blocks where the transects were short (e.g., Block 10), rotations were made every two transects. The two observers in the bubble communicated each sighting via intercom to the recorder. Sightings of all relevant biological, physical, and man-made events were reported, such as fish schools, shrimping activity, manta rays, tanker traffic, possible species associations, water color changes, and turbidity. Marine mammals were of special interest, particularly the bottlenose dolphins, (Tursiops truncatus). Observer position and code number was recorded with each sighting as a means of assessing individual observer performance and performance variability among observers.

5. Manual Recording Methods. Two types of data recording were employed during the surveys: manual entry on paper data forms, and computer entry on magnetic tape casettes. Figure 5 is an example of the field (paper) data recording form. The form was designed for simplicity, rapid entry of data, and for ease in reviewing all of the information. Spaces for notation and comments follow regular data entries. Table 1 accompanies Figure 5 with explanations of "header information", columnar entries, and interpretative codes. Recorders were responsible for accurate entry of positions and radiometer readings on a regular

basis (at least every five minutes), even when sightings were not reported. Flight logs kept by the computer provided redundant data on positions along transects and waypoints at each end of each transect. During periods when sightings occurred in rapid sucession, a data input priority was established which required that as a minimum, the species, number of animals, sighting interval, and reliability code of the identification were reported. Approximate position and time could be extrapolated.

A list of personnel is attached as Appendix 1.

6. Computerized Recording Methods: A Hewlett-Packard Model 85 microrocessor was used on board the AT-11 to provide data recording redundancy and to facilitate the post-survey transcription process. The HP-85 system is interfaced with the on-board Loran-C navigation system and Barnes PRT-5S radiometer. Using its internal clock, the HP-85 is programmed to automatically enter position and sea surface temperature every minute. These data are also automatically recorded for each sighting that is keyed in. This system virtually eliminates human error in position recording and expands the data base by sampling each minute, regardless of sighting activity. The software developed by Aero-Marine Surveys, Inc., provides an interactive, self-prompting menu selection (with user-defined keys) for each sighting category (i.e., turtle species, dolphins, number of animals, sighting interval, observer identification) and for changes in survey conditions (i.e., glare, Beaufort sea state, weather). Information on date, sampling block, transect number, and personnel is entered prior to each transect run. Other features include provision for "demand samples" for notes, the ability to set data collection priorities, and the ability to interrupt the program to accomodate the entry of a rapid succession of data. The HP-85 stores data at

intervals on a magnetic tape casette, as well as providing an immediate printout of the data (thermographic hard-copy). Figure 7 illustrates typical printouts from the computer program and the menu selection categories.

7. Data Transcription: A system was developed by Aero-Marine Surveys, Inc., to edit, review, and transfer the data from the HP-85 tapes through a Hewlett-Packard Model 86 desktop computer,whence to disc storage. The discs are compatible with NMFS computer equipment.

8. Sighting and Coverage Variables: Various factors affected sighting conditions and coverage during each survey. The most obvious factor was sea state. An inverse relationship between number of sea turtle sightings and high sea states (3-4) was apparent. A careful monitoring of sea state is necessary because changes can occur within a day due to afternoon winds, passage of weather fronts or local squalls, and changes in currents, especially in the presence of Gulf Stream bathymetry. These changes can occur gradually throughout a day or suddenly within a transect. Occasionally, therefore, a transect survey would be aborted due to a change from an acceptable to an unacceptable sea state. Under acceptability rules, a transect could only be counted if at least 65% of its length was within sea state limits of 0 to 4. Therefore, assuming a number of inevitable survey aborts, it was estimated that 2.0 aircraft days would be necessary to cover each sampling block.

Sighting curves over time indicate that time of day also influences sightability of turtles, During mid-day, turltes seem to bask at the surface. This diurnal behavior may account for a peak in the number of sightings during a sampling day. The effects of both time of day and sea state were investigated in the "Sea State

/ Time of Day Special Experiment" conducted from 10 June through 2 July 1983. The results are summarized and discussed in the following section of this report.

Other factors influencing sightings and coverage include cloudiness, fog, sun often (Glare becomes a problem at low sun angles.), local thunderstorms, airport control zone restrictions (IFR), military activity (Military test ranges are aften live.), and water turbidity (When possible, each sighting indicated whether the animal was seen at or below the surface; these observations may be correlated with turbidity estimates.).

In an attempt to standardize flight decisions regarding weather and number of days available (20/10 sampling blocks), a decision flow chart was used (Figure 8). Every attempt was made to begin a survey by 0900.

RESULTS AND DISCUSSION

This report presents some results but does not include final analyses, as this contract was primarily for data collection services. The NMFS is responsible for data interpretation and analysis.

1. Survey Calendar. The survey schedule is presented in Appendix 2 as calendars for each of the three seasonal surveys and the special experiment. The calendars show survey and non-survey dates, reason for non-survey or abort, blocks sampled, and base of operations (TIX = Titusville, FL; SAV = Savannah, GA; CHS = Charlestown, SC; and ILM = Wilmington, DE). The first flight for the spring survey was on 21 April, and the last flight for the fall/winter survey was on 14 November.

Note that in Survey VI, the percentage sampled of each block was reduced from 8% to 4.8% for Blocks 5,6,7, and 10, and to 4.0% for Blocks 1 through 4. Blocks 8 and 9 were left at 8%. This strategem was employed to reduce costs, and was based upon examination of data from last year's fall and winter surveys. In a further cost-cutting action, the October-November survey (Survey VII) combined the fall and winter surveys, both spatially and temporally, into one compact survey. Block 3 was eliminated, Block 4 was combined with Block 5, and Block 6 was combined with Block 7. And the coverage was further reduced: 3.2% samples were collected from the nine blocks, except for 4% samples from Block 8 and 9.

Not counting the Special Experiment, which was carried out from 10 June through 2 July, 52 days were required to sample 27 blocks for a ratio of 1.93 days per block. This is an improvement over last year's ratio of 1.88 days per block. Only two sampling blocks were eliminated as a result of weather delays (Blocks 1 and 2 of the fall-winter survey). Table 4 summarizes the dates and coverage for each survey.

2. Survey Coverage. Since each survey required a new set of randomized transects for each block, the coverages were not identical from survey to survey. The percent of each block covered was further altered circumstantially by weather, sea states, military zone restrictions, and the sightability factors discussed above. Table 5 lists the coverage of each sampling block in the survey.

3. Distribution of Turtles.

a.) Spatial Distribution. Distributional maps of the study area can be generated from the computerized data bases at NMFS for each survey, as they were for the 1982 season.

b.) Seasonal Distribution. Comparisons of sightings by sampling block and species - Caretta caretta , Dermochelys coriacea , Chelonia mydas , and unidentified - has been compiled through histograms (Figures 9 - 12: The scales of Figures 10, 11, and 12 are 1/10 of the scale of Figure 9). Total turtle sightings are compared similarly in Figure 13 (which is the same scale as Figure 9), and can be used to visualize seasonal shifts in distribution and changes in relative abundance. Note that these comparisons are unweighted relative to effort, are not normalized, and are thus useful only as relative comparisons. However, the differences in overall abundance are particularly evident between the spring-summer surveys and the fall-winter survey on Figure 13 (keeping in mind that no data were collected for Blocks 1 through 3 on the fall-winter survey). The percent of all sightings are relatively insignificant in both the fall and the winter. This was noted in the 1982 survey, and was one of the reasons for combining the fall and winter surveys into one fall/winter survey. In the spring and summer surveys, approximately 33% and 73%, respectively, of all turtle sightings occurred in Blocks 8 and 9.

As seen from Figure 9, Caretta caretta was numerous throughout the study area in the spring, with Block 8 having roughly twice as many sightings (248) as any other block (where sightings ranged between 59 and 132). In the summer, the number of sightings were 1/3 of the spring sightings and the distribution of Caretta caretta shifted to the south, with peaks of 130 and 74 respectively in Blocks 8 and 9. The winter distribution was apparently uniformly sparse. This

repeats the 1982 findings.

Unidentified turtles show the same seasonal distribution patterns as Caretta caretta , with the exception that the pronounced spring peak in Block 8 (Figure 12) does not occur.

Somewhat the same distributional patterns are seen for Dermochelys coriacea as for Caretta caretta . There is again a shiift toward the south from spring to summer, with a strong summer peak in Block 8. Fall/winter sightings are practically nil. This, too, repeats the 1982 findings.

The sightings of other species were so rare that no seasonal distribution trends can be observed.

The numbers of turtle sightings are shown in Appendix 3, which contains the tables taken from the three seasonal survey reports. Figures 9 through 13 were derived from these data.

c) Numbers of Turtles. A summary of the sea turtle sightings by season ~~is~~ is given in Table 6. Caretta caretta was by far the dominant species, with 1458 animals or 85.0% of the total number of turtles (1715). Only 100 Dermochelys coriacea were identified (5.8% of the total), and over half of these were seen one day during the summer survey in Block 8. These figures are nearly the the same as reported in 1982. The major change is in unidentified turtle sightings, where in 1983 only 8.7% were unidentified, against 14.5% in 1982.

Only six Chelonia mydas and two Lepidochelys kempi were identified from the

grand total of 1715. No Eretmochelys imbricata were identified. Again, these ~~those~~ figures are close to the 1982 figures, and indicate either that few of these species are to be found in the study area, and/or that aerial surveys as presently conducted are not effective for identifying these species. In the latter case, the relatively small size of Eretmochelys imbricata and Lepidochelys kempi may be a factor. Their behavior, including diurnal habits, may also limit surface activity. However, far too few identifications were made to be able to draw any conclusions.

4.) Distribution of Marine Mammals

a.) Seasonal Comparisons. Although the sampling design for the turtle survey was not optimum for marine mammal sighting, many data were collected. Particular emphasis was placed on the most abundant species, Tursiops truncatus , the bottlenose dolphin. Table 7 lists the occurrance of marine mammals by season. The detailed tabularized accounts from which Table 7 was compiled are given in Appendix 5. Histograms were not prepared for this data.

Approximately 2000 marine mammals were encountered, of which about 79% were identified as Tursiops truncatus . Stenella spp., generally Stenella plagiodon , were also frequently identified, providing about 10% of the total count. Unidentified dolphins comprised about 11% of the total.

5.) Sea State / Time of Day Special Experiment.

The objectives of this experiment were twofold:

a.) to determine the effect of sea state on the sightability of sea turtles, using the intervals Beaufort 0-1, 2-3, and 4, and

b.) to determine the effect of time of day (during daylight hours) on the sightability of sea turtles, using the intervals 0700-0900, 0900-1100, 1100-1300, 1300-1500, and 1500-1700.

For any given sampling day, the basic sampling scheme was identical to that of the seasonal surveys, and randomly sampled 16% of a section of Block 8 (Figure 14).

It is possible to collect data throughout the time of day intervals for each of the three sea states; in practice, the experiment was able to collect data for eleven of the possible fifteen combinations, and shown by the Sea State vs Time of Day matrices in Appendix 4.

A total of 688 sea turtles were identified throughout the survey period in those sampling grids that met survey criteria. The loggerhead (Caretta caretta), was by far the most dominant species, with a total of 579 sightings or 84% of all sightings. There were 85 leatherbacks (Dermochelys coriacea), identified, accounting for 12% of the sightings. These percentages closely follow the 1982 - 83 seasonal survey data.

About 460 marine mammals were observed during this survey, using the criteria applied to sea turtles. The bottlenose dolphin (Tursiops truncatus), was by far the the most dominant species sighted, accounting for about 87% of the individuals identified.

Table 1. EXPLANATION OF FIELD DATA FORM ENTRIES.

TOP: Observers [L=left; R=right; and observer numerical code ( )]
Recorder [name and/or numerical code]
Crew personnel [pilot/co-pilot]
Survey area [sampling block #]
Date [coded in 6 digits year month day]
Page [sequential for survey day]

Transect number [sequential transect within a sampling block]

Time [2400 hr. designation at time of sighting or data entry]

Number animals + [# of animals seen + variability of estimate; e.g., 20 + 5 dolphins]

Species ID-M,F [coded identification as given in Table 2] M=male, F=female

Sighting Interval [1-5 as designated through distance calibrations]

Reliability code [1=unsure, 2=possible, 3=positive]

S,U [S=animal on surface, U=below surface]

Location; latitude, longitude [position as taken from Loran-C computer display]

Observer number [numerically coded observer responsible for the sighting]

Notes [comments on sighting or additional space for event recording]

Sea State [Beaufort scale 0-5; effective coverage limited to <4]

Glare [right and left observer glare; N=nose, S=slight, M=moderate, SV=severe]

Sea T [sea surface temperature taken from radiometer output]

Turbidity [clarity of water C=clear, M=moderately turbid, T=turbid]

Clouds [indicative of weather C=clear, BKN=broken, OC=overcast, % shadow=cloud shadow in swath area]

Visibility [miles of visibility (horizon @ 32 miles with clear visibility @ 500')]

Table 2. Protocol for transcription of SETS pelagic data.

TRANSCRIPTION SOURCE FOR PELAGIC AERIAL SURVEY

Column #	
1	Data source - Survey #1 = 1, Survey #2 = 2, Survey #3 = 3, Survey #4 = 4
2-7	Date - year month day (2 col. each)
8-9	Survey area # = 1-10
10-13	Time - hours minutes (military time/24 hour clock)
14-16	Sighting # - # assigned to keep count of target species (turtles, mammals); assigned by transcriber.
17-20	# animals
21-23	$\pm$ # animals
24-25	Species - species to be numerically coded, 01-99
26	Sex - to be numerically coded, blank-2
27	Sighting interval = 1-5
28	Reliability of ID 1-3
29-33	Latitude
34-38	Longitude
39	Turtle appearance - sighted above or below water surface, numerically coded, 1-2.
40-41	Observer # - numerically coded (see list)
42-44	Notes - numerically coded 001-999 (see list)
45-47	Sea temperature - measured in nearest tenth °C (entered as integer)
48	Sea state = 1-9
49	Turbidity - numerically coded 1-3
50	Glare - numerically coded 1-4
51	Side - numerically coded 1-2
52	Cloud condition - numerically coded 1-3
53-55	Cloud cover - (%)

Table 2. (continued)

56-57	Visibility - in nautical miles
58-61	Depth - measured in fathoms
62-63	Transect # - dependent on survey area
64	Transect information - numerically coded 1-9
65	Transect made good? - numerically coded blank-1
66-68	Other notes not in previous notes or transect information, numerically coded 1-
69-70	Observer 1 (on left of plane, sights right side) numerically coded (see list)
71-72	Observer 2 (on right of plane, sights left side) numerically coded (see list)
73-74	Recorder - numerically coded (see list)
75-76	Pilot - numerically coded (see list)
77-78	Co-pilot - numerically coded (see list)
79-81	Velocity - (average ground speed from Loran C)
82-84	Altitude - 500 feet
85-87	Mileage per transect (nm) from Loran C
88-90	Mileage in transit (nm) from Loran C
91	Aircraft type - numerically coded

Table 2. (continued)

QUICK REFERENCE: All variables to be entered as integers.
Variables which are reals can be output as reals.
C = numeric coding to be done by transcriber.

I1 - Data source
I6 - Date - yr, mo, day
I2 - Survey area
I4 - TIME - hrs, min
I3 - Sighting #
I4 - # animals
I3 - + # animals
I2 - Species C
I1 - Sex C
I1 - Sighting interval
I1 - Reliability
I5 - Latitude 1
I5 - Longitude
I1 - Turtle appearance C
I2 - Observer # C
I3 - Notes - biological, etc. C
I3 - Sea temp (°C)
I1 - Sea state
I1 - Turbidity C
I1 - Glare C
I1 - Side C
I1 - Cloud condition C
I3 - Cloud cover (%)
I2 - Visibility
I4 - Depth
I2 - Transect
I1 - Transect info: (i.e., beginning, off track, etc.) C
I1 - Transect made good? C
I2 - Other notes - (not in notes of trst info) C
I2 - Observer 1 (on left of plane, sights right side) C
I2 - Observer 2 (on right of plane, sights left side) C
I2 - Recorder
I2 - Pilot
I2 - Co-pilot
I3 - Velocity (avg. ground speed)
I3 - Altitude
I3 - Mileage per trst (nm)
I3 - Mileage in transit (nm)
I1 - Aircraft type

Table 2. (continued)

QUICK REFERENCE

Turtle Aerial Survey -- Pelagic Coding Information

Sex
F = 1
M = 2
J = 3 (juvenile)
blank = unknown

Turtle Appearance
S = 1
U = 2

Turbidity
C = 1
M = 2
T = 3

Glare
N = 1
S = 2
M = 3
SV = 4

Side
R = 1
L = 2

Clouds
C = 1
BKN = 2
OC = 3

Data Source
1 = dedicated pelagic survey
2 = additional survey

Aircraft type
1 = Beech AT11

Transect info
1 = beginning of track
2 = off track
3 = in transit
4 = survey aborted
8 = transect not completed/end
9 = end of track

Transect made good?
1 = no
blnk = yes

Note Codes:

01) small turtle (any spp. or un.) - juvenile?
02) large turtle (any spp. or un.)
03) possible mating (close association - touching etc.)
04) dead (any spp. or animal)
05) very light coloration (any spp. or un.)
06) very dark coloration (any spp. or un.)
07) apparent tagged animal
08) in association with shrimp boats
09) close to other vessel or human activity such as sportfishing, dredging, etc.
10) apparent feeding (for porpoises, etc.)
11) one observer temporarily indisposed
12) both observers temporarily indisposed
13) sighting verified by non-observers aboard
14) sighting contradicted by non-observers aboard
15) multispecies aggregation, association - stated in notes
16) turtle nesting crawl on beach
17) stranded animal on beach
18) area affected by tidal waters from local inlet or river discharge
19) large freighter or ship in area
20) oil slick evident on surface
21) gulfstream border evident or presumed
22) localized storm - left transect to avoid
23) rain partially obscuring sighting conditions
24) conditions require alternate transect
25) Loran unit -- temporary dysfunction
26) large amount of debris in water
27) weed lines prominent in area
28) color change in water (blue-green)
29) sighting made in transit or between transects
30) sighting made at altitude other than 500 feet
31) radiometer not working
* 32) animal diving actively, possibly in response to aircraft
33) animal at suboptimal orientation relative to aircraft, may affect proper identification
34)
35)
36)
37) fog
38) not observer -- left side
39) not observer -- right side
40) large turtle shaped object
41) mammal appearance, surface
42) mammal appearance, under surface
43) shoaling
44) mission aborted due to excess seq state
46) rain begins
47) rain stops
48) rain squalls in area
49) avoiding storm, modified trackline
50) several/amny/group/lots of
51) reeg area

Table 2. (continued)

Note Codes (continued):

52) can see bottom (inbound leg)
53) depth -- becomes deeper (or entering deeper water)
54) depth -- becomes shallower
55) widespread -- in general area (such as # of shrimp boats, etc.)
56) surface disturbance
57) possible mother and calf (marine mammals)
58) probable calf (marine mammals)
59) prominent swells
60) animal apparently on bottom
61) headings for transits
62) fixed fishing gear in area
63) along shoreline -- at beach
64) hazy horizon -- may affect visual horizon regerence
65) military warning area -- acrive, modified brackline
66) *EST
67) *EDT
68) spotted eagle ray
69) notable bird sightings
70) Loran dumped
71) sargassum
72) Change in water Mass

Table 2. (continued)

TURTLE AERIAL SURVEY - PELAGIC CODING INFORMATION

Participants

1) J. Olsen	2) N. Solomon	3) Hoffman	4) T. Wilson	5) S. Chestnut
6) B. Schroeder	7) G. LeBaron	8) A. McGehee	9) T. Thompson	10) Hoggard
11) Gilman	12) Campbell	13)	14)	15)
16)	17)	18)	19)	20)
21)	22)	23)	24)	25)
26)	27)	28)	29)	30)
31)	32)	33)	34)	35)
36)	37)	38)	39)	40)
41)	42)	43)	44)	45)
46)	47)	48)	49)	50)
51)	52)	53)	54)	55)
56)	57)	58)	59)	60)

1) Olsen (pilot)

2) Solomon (co-pilot)

11) Gilman (co-pilot)

12) Campbell (co-pilot)

Table 3. Species and parameter codes for SETS pelagic surveys

SPECIES CODE

01=Unidentified turtle	UN
02=Caretta caretta	Loggerhead
03=Chelonia mydas	Green
04=Dermochelys coriacea	Leatherback
05=Eretmochelys imbricata	Hawksbill
06=Lepidochelys kempi	Kemp's ridley
07=Trichechus manatus	Manatee
08=Tursiops truncatus	Bottlenose dolphin
09=Unidentified dolphin	UNDO
10=Stenella plagiodon	Spotted dolphin
11=Unidentified marine mammal	UNMM
12=Globicephala macrorhynchus	Pilot whales
13=Kogia spp.	Pygmy or dwarf sperm whale
14=Pseudorca crassodens	False killer whales
15=Balaena glacialis	Right whales
16=Megaptera novaeangliae	Humpback
17=Balaenoptera acutorostrata	Minke whale
18=Balaenoptera edeni	Bryde's whale
19=Balaenoptera physalus	Fin whale
20=Physeter macrocephalus	Sperm whale
21=Stenella coeruleoalba	Striped dolphin
22=Stenella longirostris	Spinner dolphin
23=Steno bredanensis	Rough toothed dolphin
24=Mesoplodon spp.	Beaked whales
25=Ziphius cavirostris	Goosebeaked whale
26=Grampus grisieus	Grampus
27=Stenella spp.	Bridled dolphin
28=Manta birostris	Manta
29=Rhinoptera bonasus	Cow-nosed ray
30=Sphyrna spp.	Hammerhead shark
31=Fish school	
32=Billfish	
33=Unknown shark	
34=Mola mola	Ocean sunfish
35=Cetorhinus maximus	Basking shark
36=Rhincodon typus	Whale shark
37=Unidentified ray	
38=Unidentified animal	

Surface = 1
Below = 2

Sex = 1 = Female
2 = Male
3 = Undetermined

Table 4. Summary of Survey Dates and Coverage

SURVEY	INCLUSIVE DATES	NUMBER OF BLOCKS SURVEYED	DAYS/SAMPLE
Spring	21 April - 7 May	10	17/10 = 1.70
Special Experiment	10 June - 2 July	N.A.	
Summer	18 July - 5 Aug	10	19/10 = 1.90
Fall/Winter	31 Oct - 14 Nov	7 (See note.)	16/7 = 2.29
Annual			52/27 = 1.93

Note: Blocks 1 and 2 missed due to weather.

Table 5. Percent Coverage in Survey Blocks Compared by Season

BLOCK	SPRING 1983 Goal/Actual % %	SUMMER 1983 Goal/Actual % %	FALL/WINTER 1983 Goal/Actual % %
1	8.0/8.13	4.0/4.11	(1)
2	8.0/7.64	4.0/4.32	(1)
3	8.0/7.94	4.0/4.15	(2)
4	8.0/8.03	4.0/4.39	3.2/3.15
5	8.0/7.74	4.8/3.70	
6	8.0/8.36	4.8/4.37	3.2/3.20
7	8.0/7.75	4.8/4.84	
8	8.0/8.37	8.0/8.43	4.0/3.98
9	8.0/8.13	8.0/7.77	4.0/4.52
10	8.0/7.08	4.8/4.57	3.2/3.13

(1) Missed due to weather.

(2) Eliminated from survey.

TABLE 6. Southeast Turtle Survey: Turtle sightings, by species, by season. Numbers shown represent numbers of individuals. (1)

SEASON	C.caretta	D.coriacea	L.kempi	E.imbricata	C.Mydas	Unident Turtle	Total Turtles
Spring	1086	35	2	0	2	121	1246
Summer	294	60	0	0	4	21	379
Fall/ Winter (2)	78	5	0	0	0	7	90
Total	1458	100	2	0	6	149	1715
Percent	85.0	5.8	0.1	0.0	0.3	8.7	100.0

Notes: (1) All reliability code sightings included in these figures.
(2) No data from Blocks 1,2 or 3.

TABLE 7. Southeast Turtle Survey; Marine mammal sightings, by species, by season. Numbers represent individuals sighted. (1)

SEASON	T.truncatus	Stenella spp	Stenella plagiodon	Unident Dolphin	Unident Mar Mam	Total Mar Mam
Spring	1151	81	no data	106	2	1342
Summer	291	102	(88)	115	1	509
Fall/ Winter (2)	176	16	(15)	10	0	202
Total	1618	199	N.A.	231	3	2053
Percent	79	10	-	11	0	100

Notes: (1) These figures contain an error of between 5 to 10%
(2) No data was collected for Blocks 1,2 and 3.

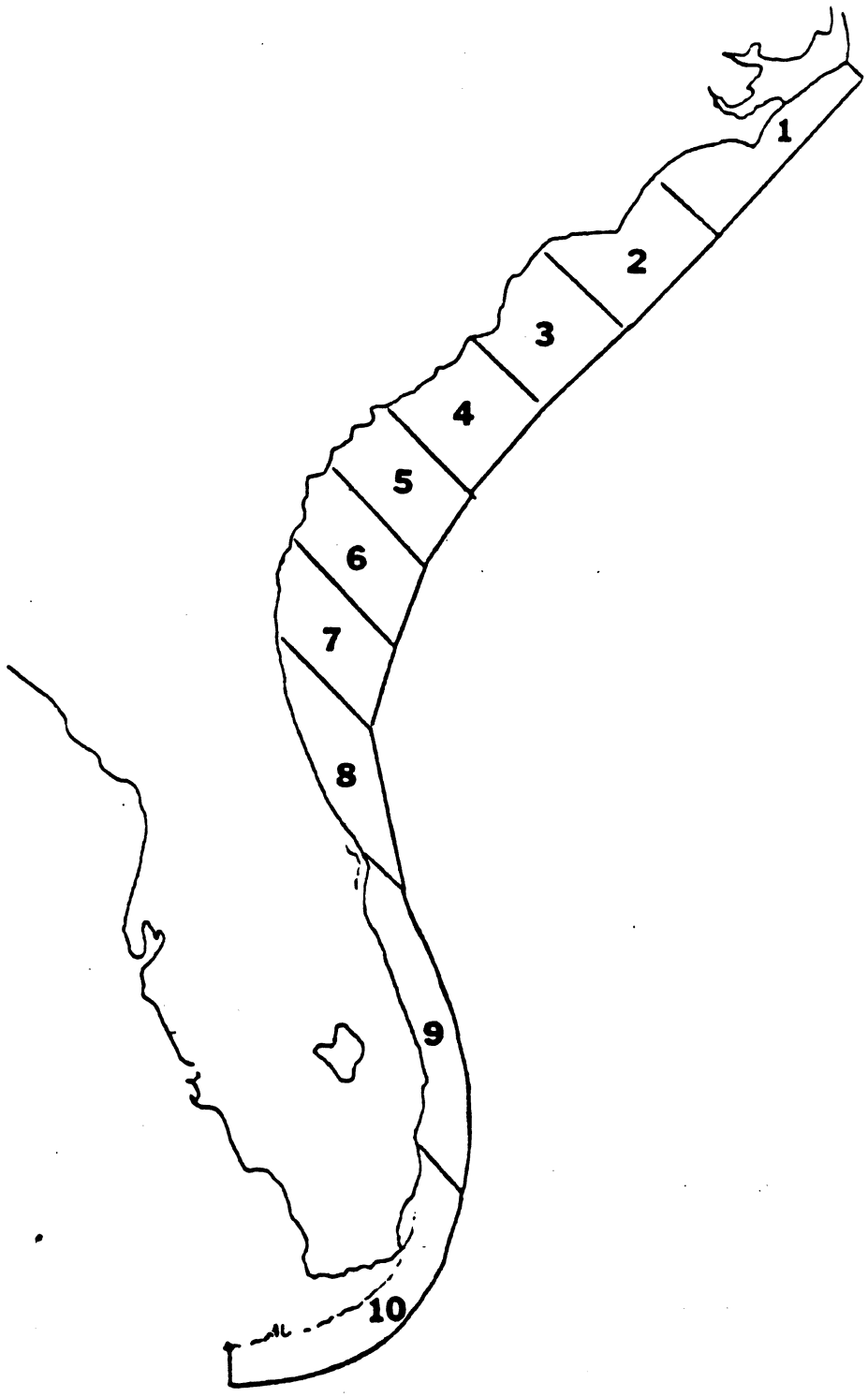


Figure 1. Map of the southeast Atlantic coastline illustrating the ten sampling blocks for the Southeast Turtle Survey.

No Figure 2

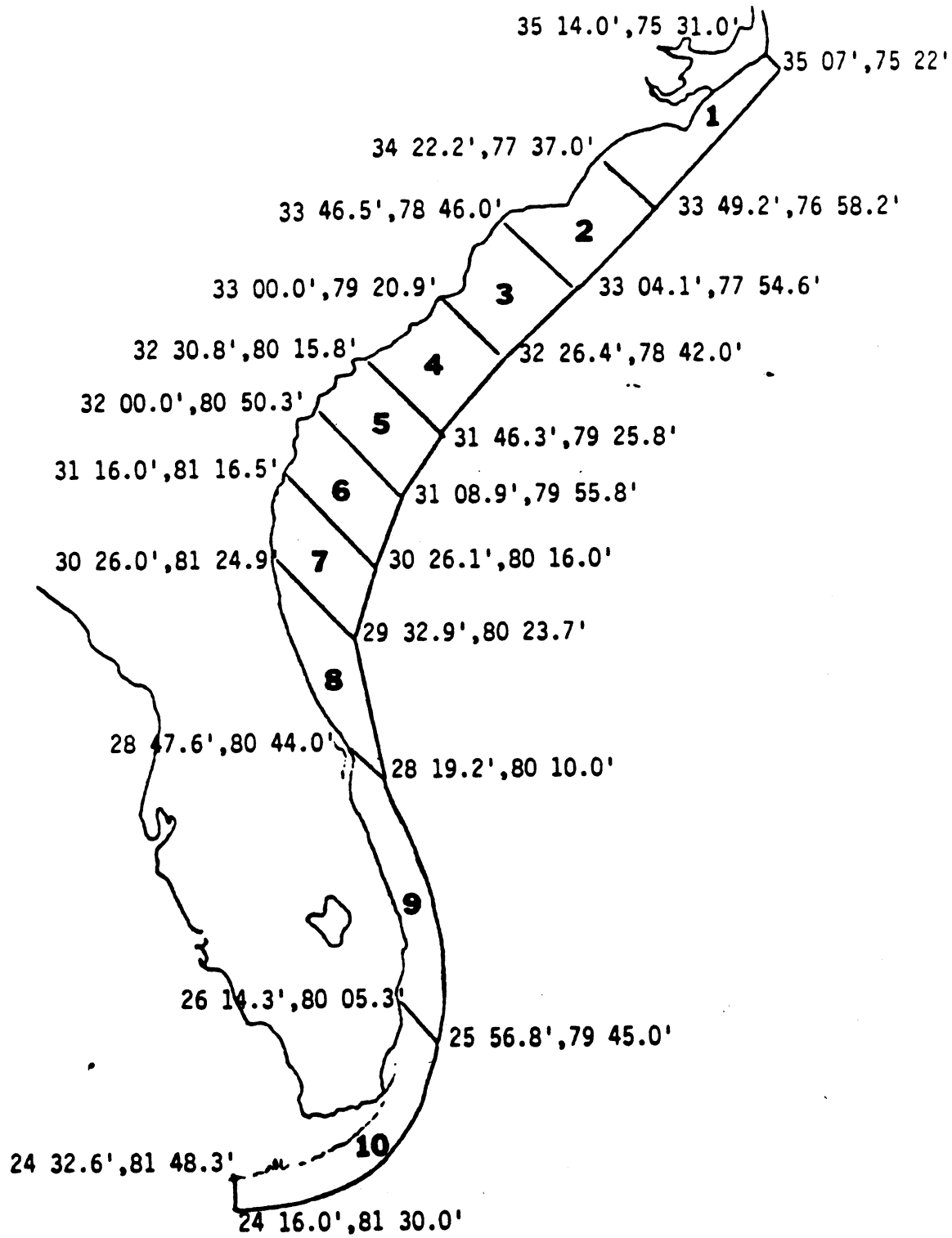


Figure 3. Coordinates of inshore and offshore borders of the ten sampling blocks.

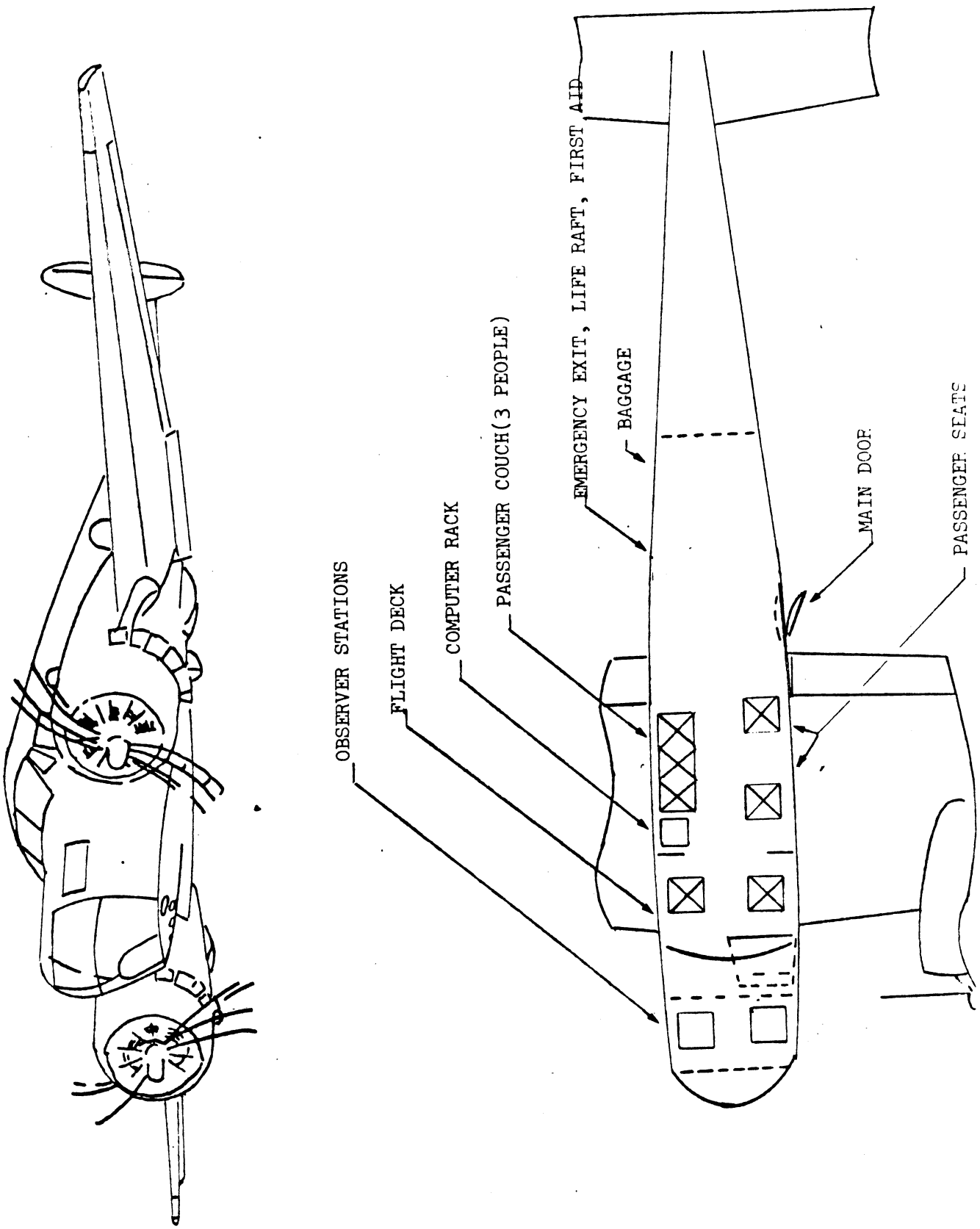
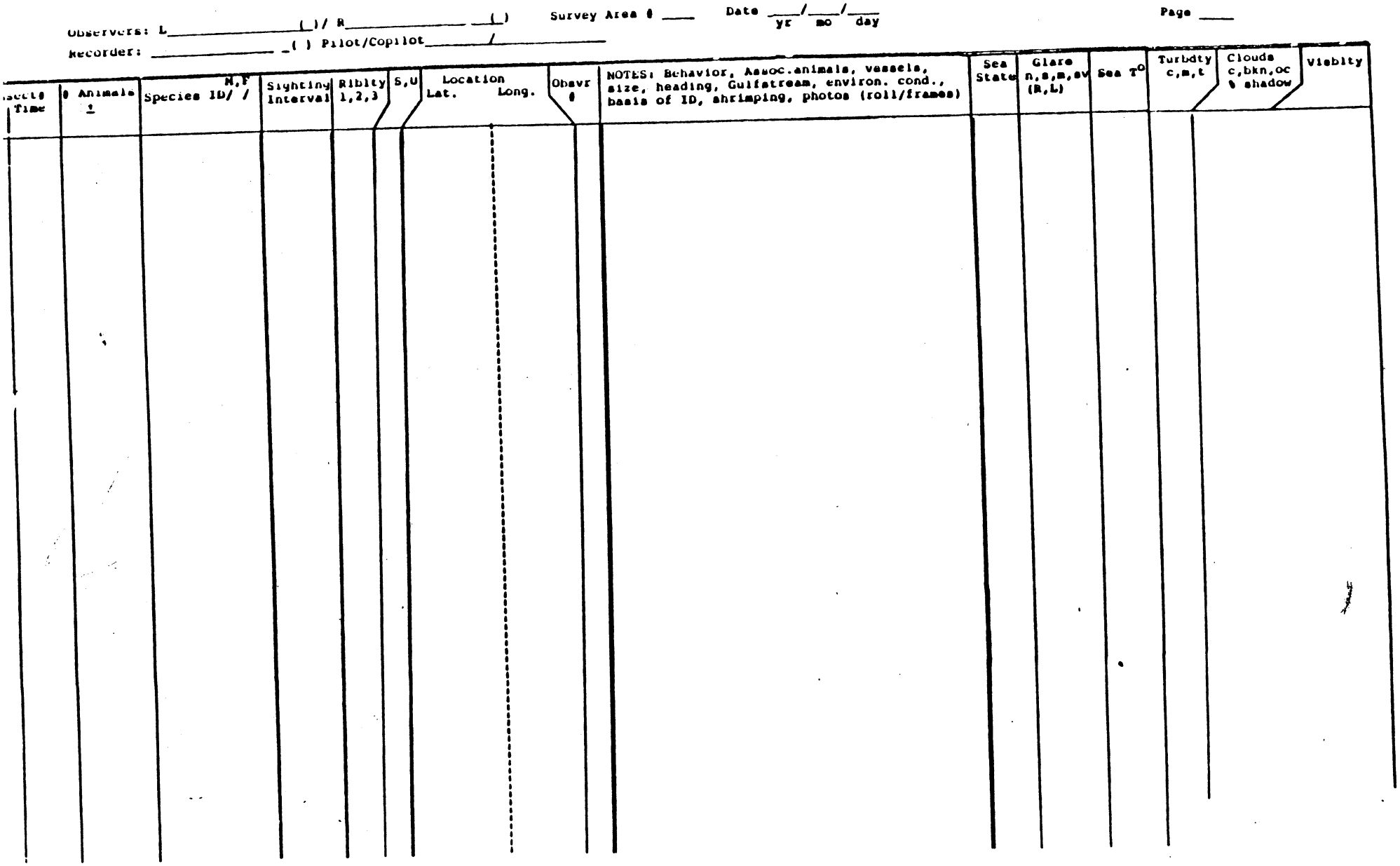


Figure 4. Configuration of AT-11 survey aircraft.

Figure 5. Field data recording forms utilized i. .he pelagic aerial survey.



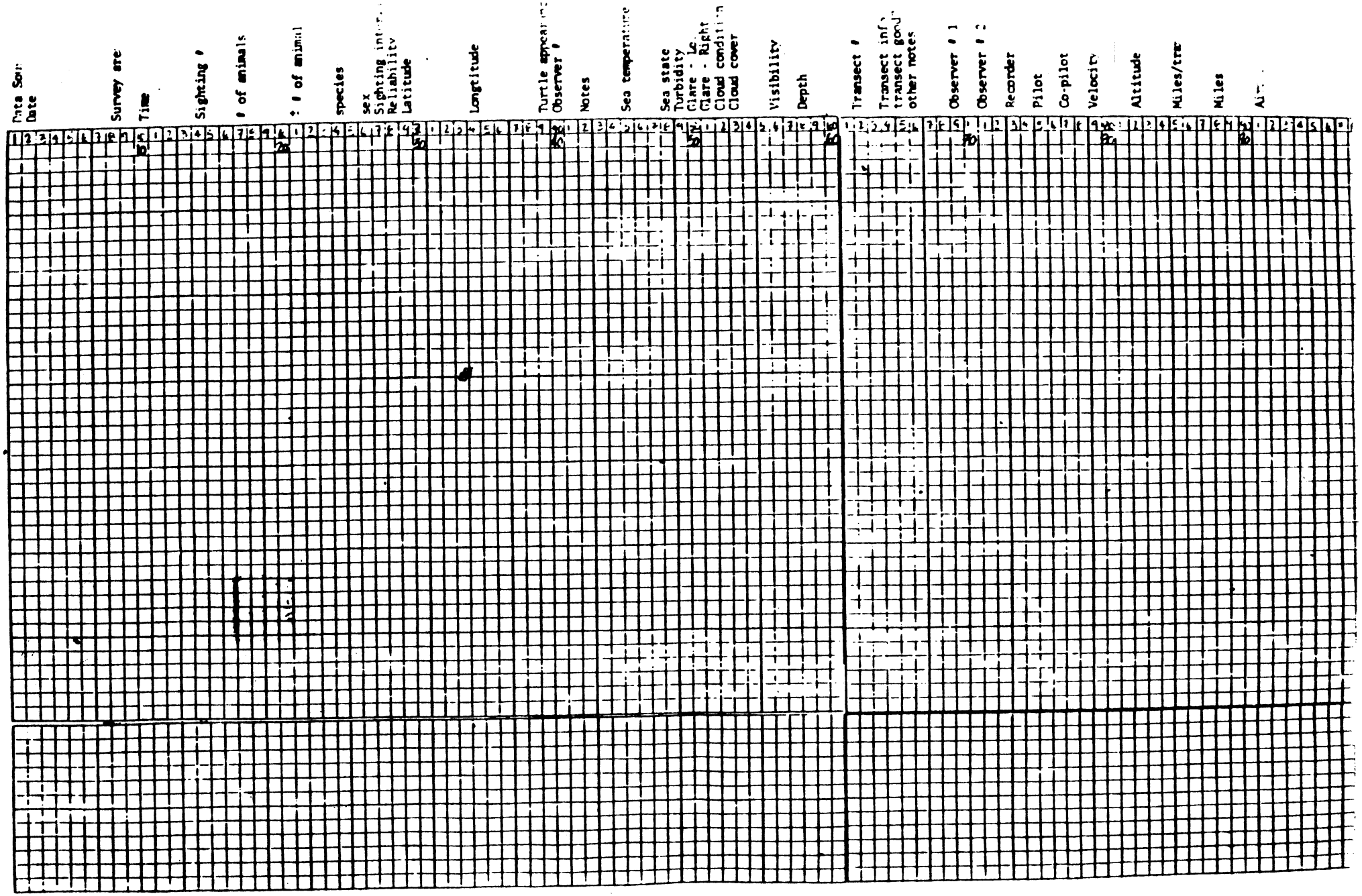


Figure 6. Sample transcription form for computer entry of field data.

Figure 7. Examples of printouts from the computer on board with the menu selection categories, sighting inputs, and automatic positional data.

```
-----------------------------------
TURTLE  DOLPHIN-  FISH   WHALE
******  MANATEE   ====   +++++
```

A Sighting Category

Species Category **B**

```
CARETTA CARETTA              1
DERMOCHELYS CORIACEA         2
CHELONIA MYDAS               3
ERETMOCHELYS IMBRICATA       4
LEPIDOCHELYS KEMPI           5
Unidentified TURTLE          6

Enter SPECIES #
?
```

```
09 39 00
283076 0804749 000P1038 000
 10
-------------------

TURTLE          1
SPECIES         2        1
QUANTITY        3        2
VARIABILITY     4        0
SEX             5        3
INTERVAL        6        63++
RELIABILITY     7        3
SURFACE/SUB     8        1
NOTE 1          9        1
NOTE 2         10        1

Any changes? Y or N
?
N
```

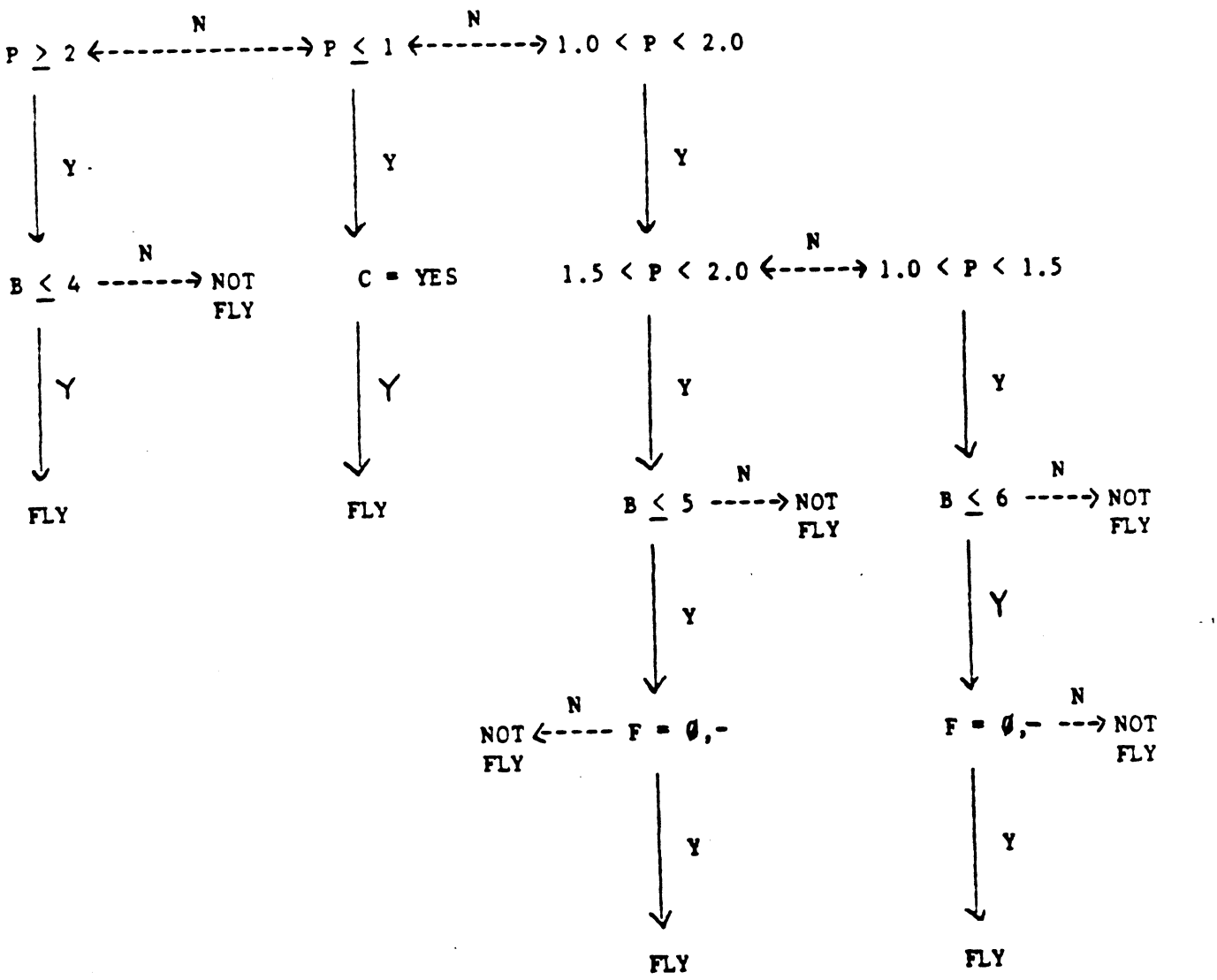
C Sighting Input

++indicates Observer and sighting interval

Time — 09 39 06
Position — 283076 0804749][000P1038 000 — Heading, tracking information
Temperature — 10

```
=====================
09 40 00
283076 0804749 000P1038 000
 10
-------------------
```

D One minute positional update



A = Days Available
R = Days Required
B = Beaufort Sea State
C = Pilot Clearance
F = Forecast, Ø = Unchanged; - = Deteriorating, + = Improving
Y = Yes
N = No

Figure 8. Decision flow chart designed to facilitate mission abort decisions concerning excessive sea states and time available. Pilot clearance is required for all affirmative decisions.

FIGURE 9

Seasonal comparisons of Caretta sightings by sampling block.

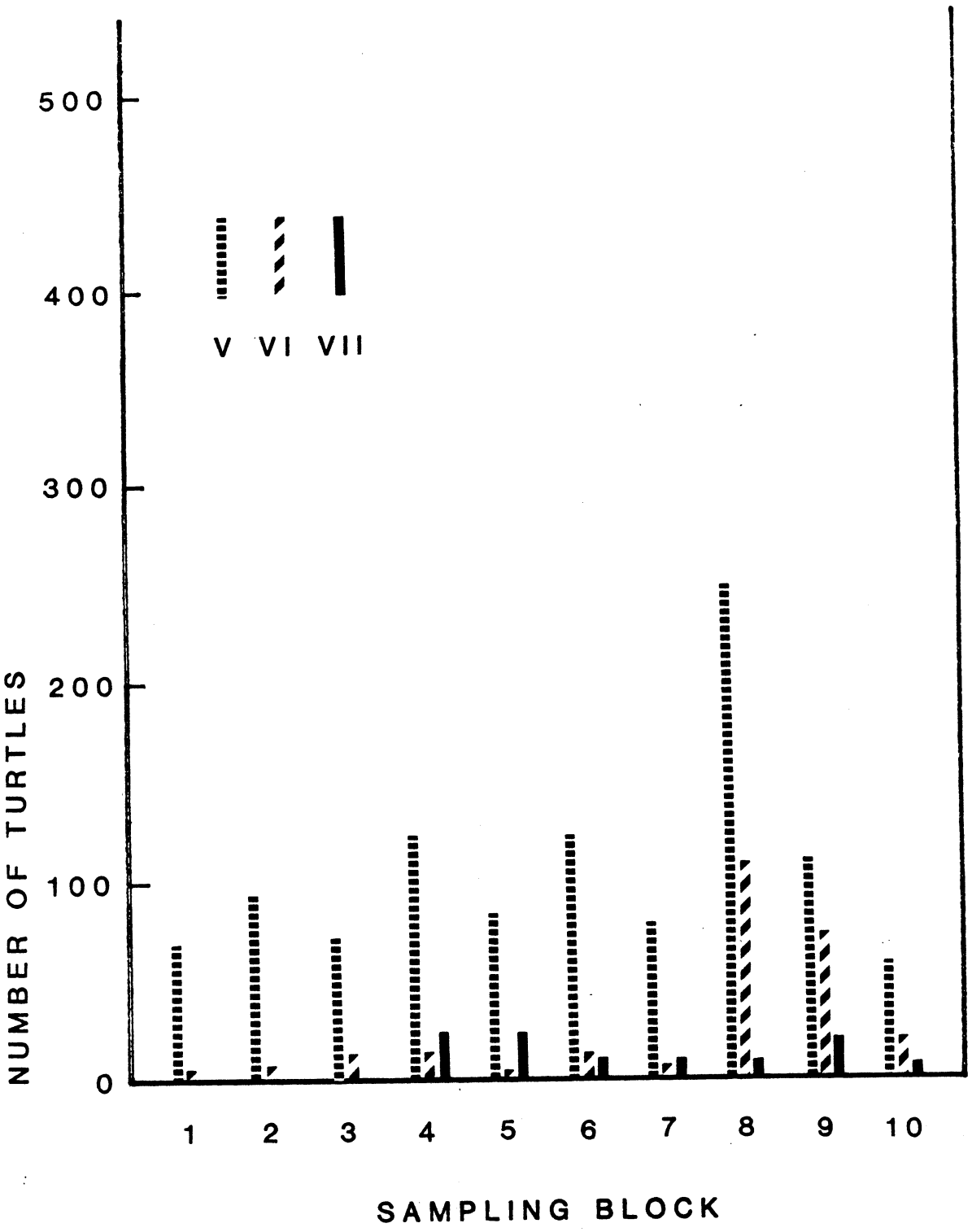


FIGURE 10

Seasonal comparisons of Dermochelys sightings by sampling block.

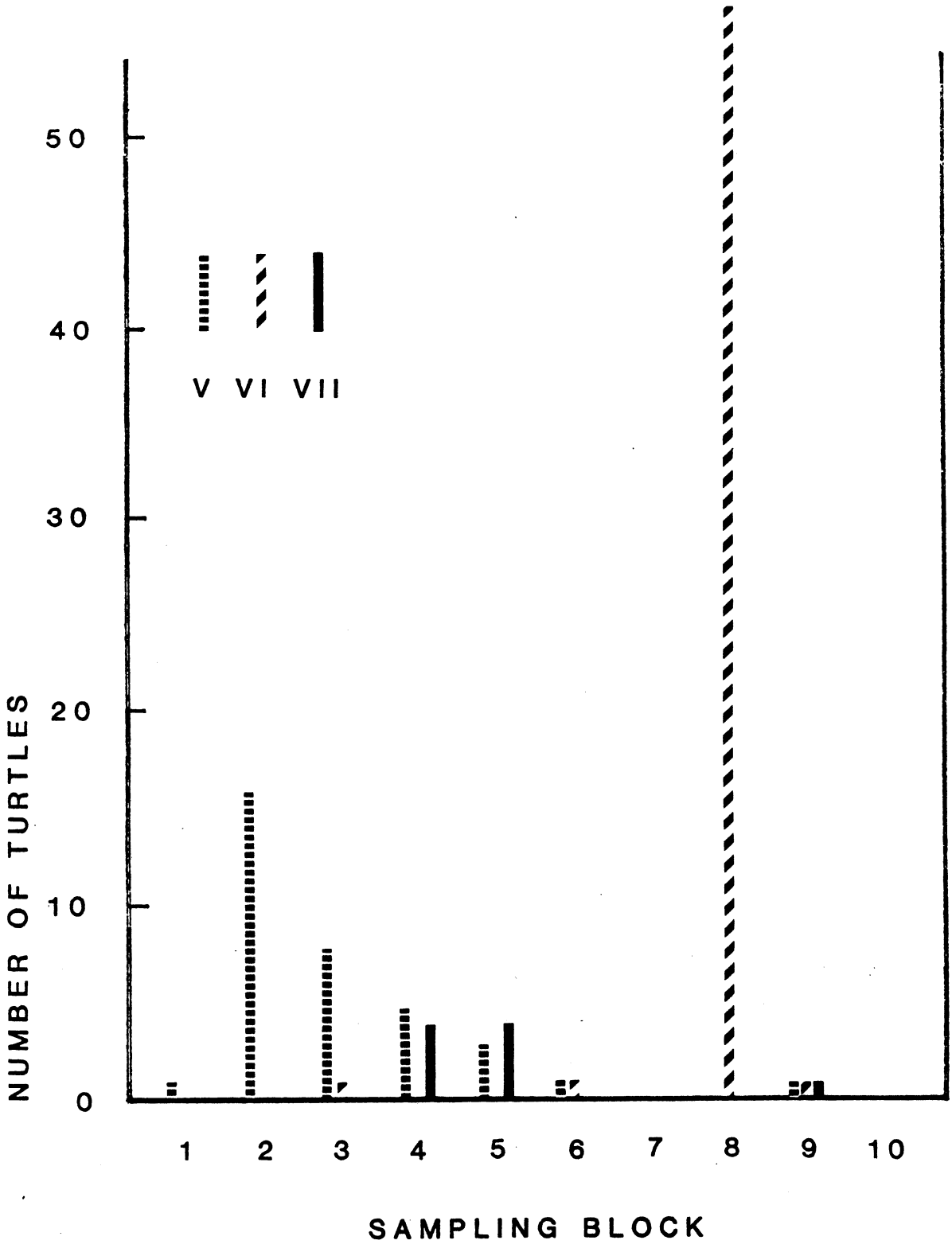


FIGURE 11

Seasonal comparisons of Chelonia sightings by sampling block.

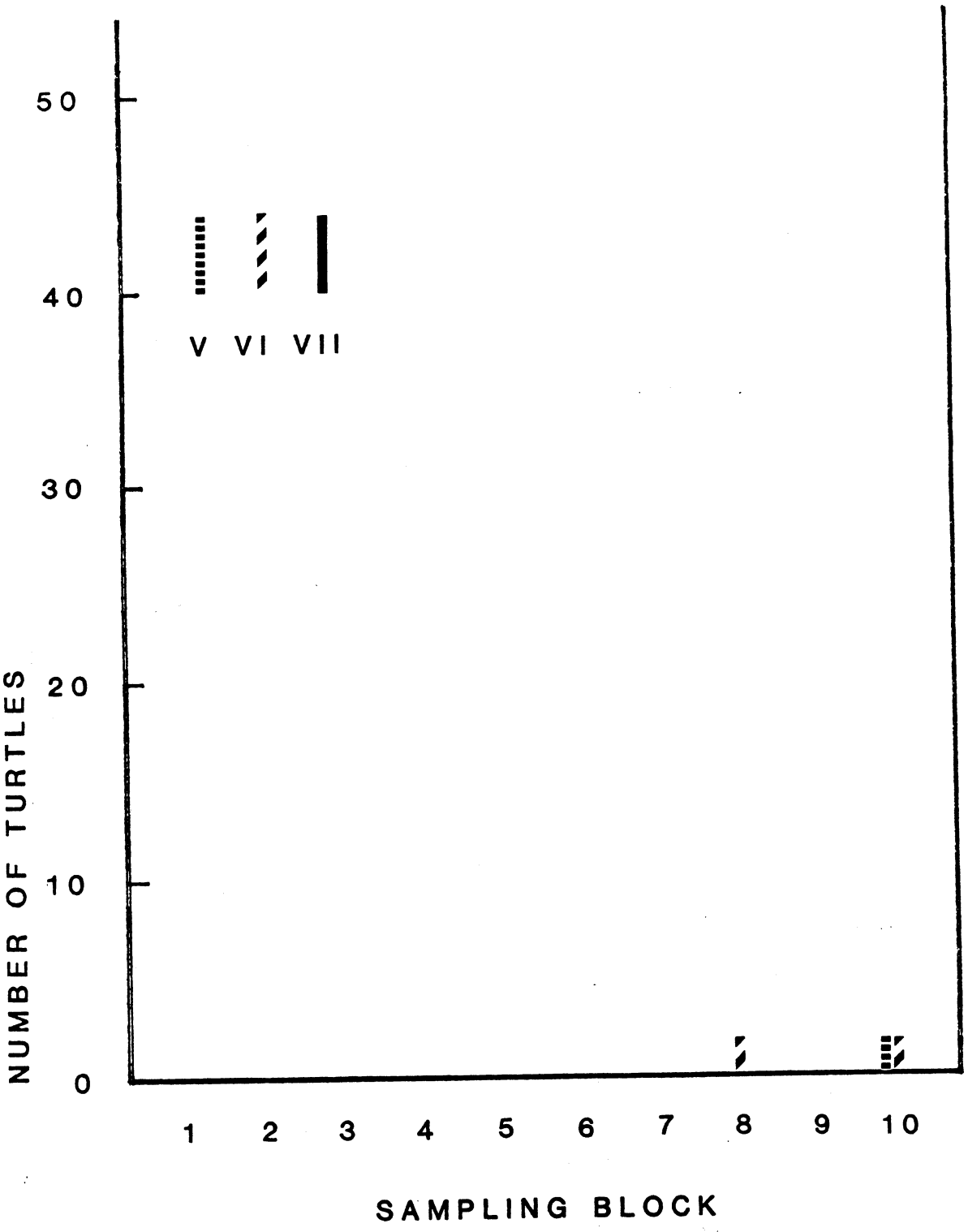


FIGURE 12

Seasonal comparisons of unidentified turtle sightings by sampling block.

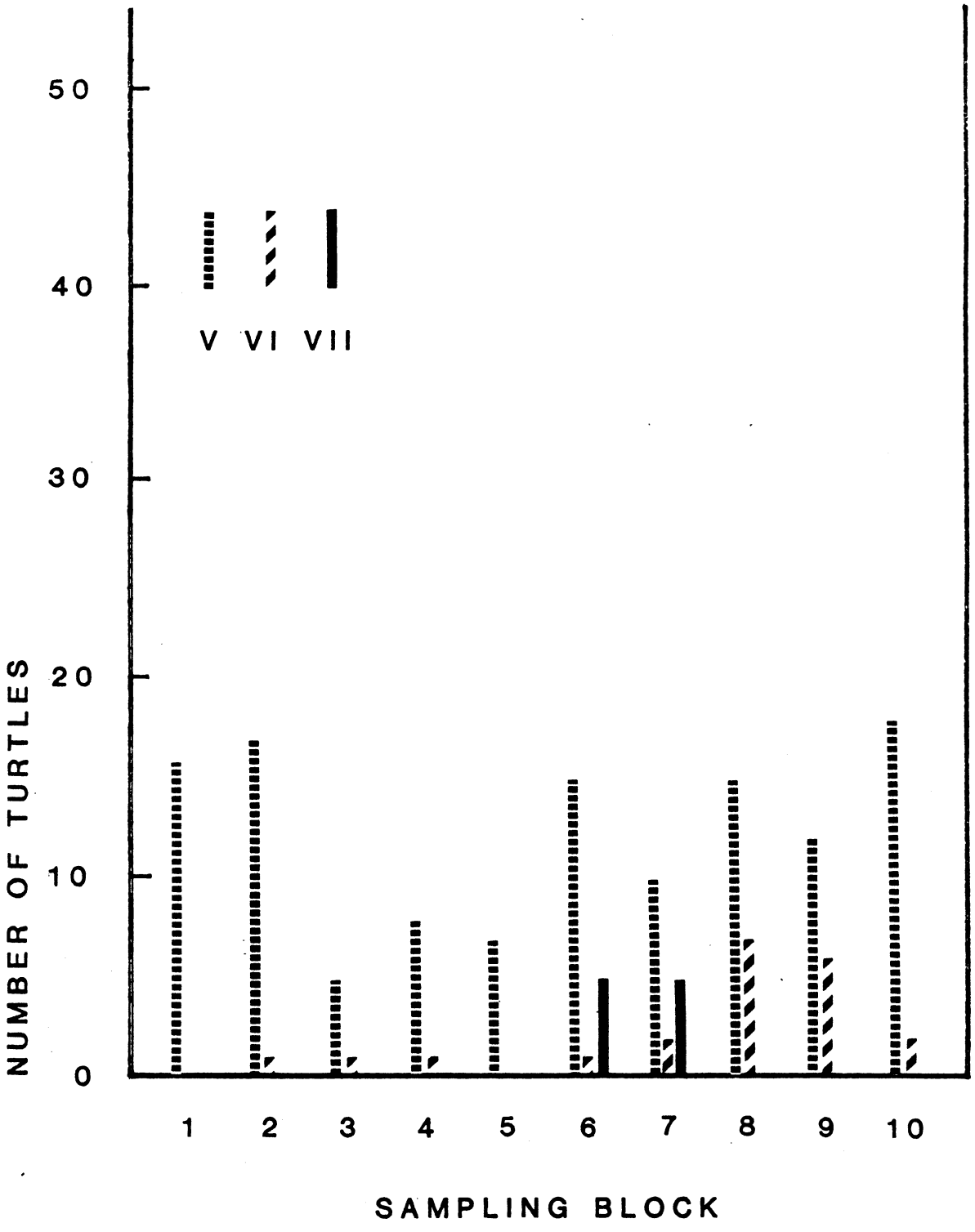


FIGURE 13

Seasonal comparisons of total turtle sightings by sampling block.

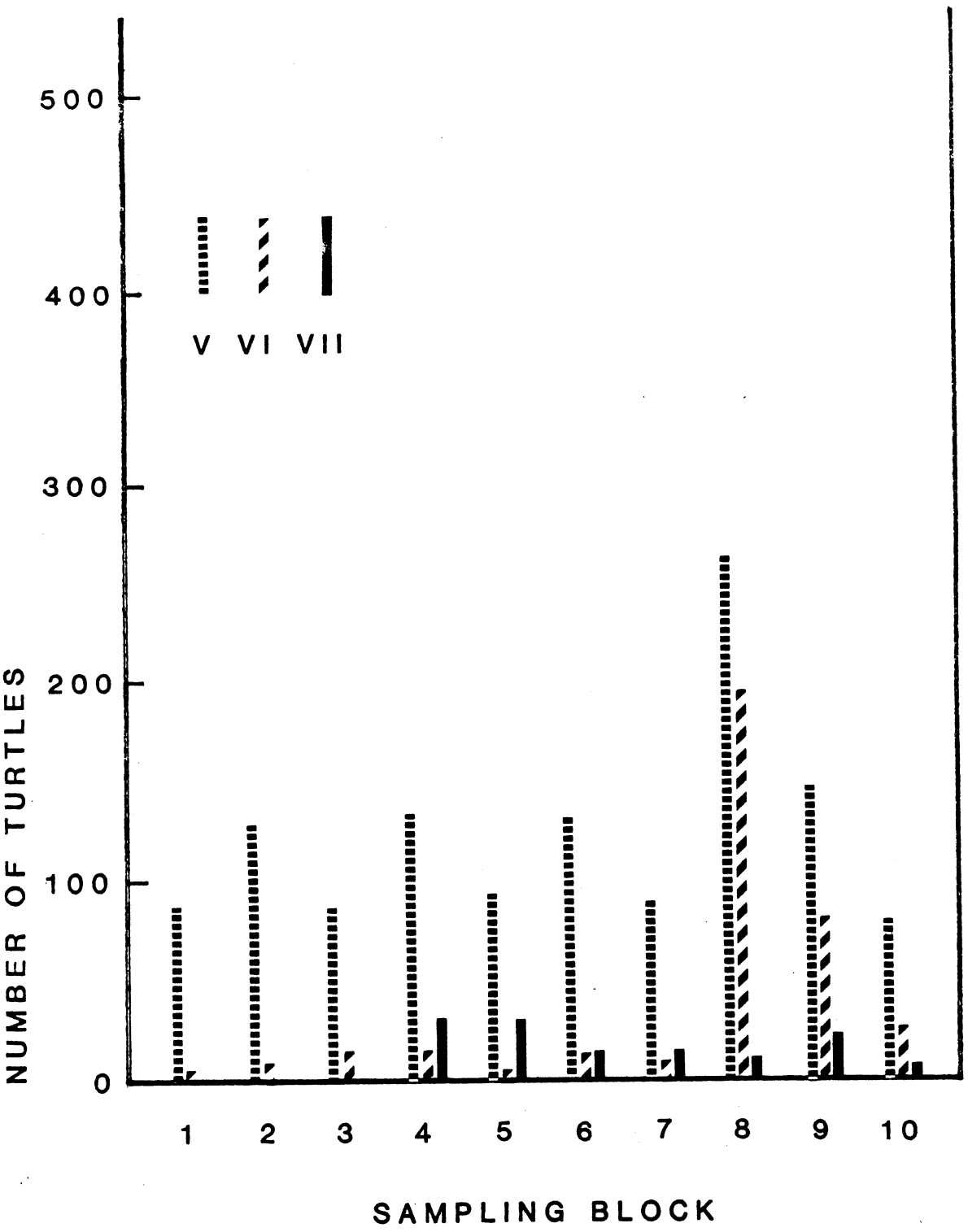
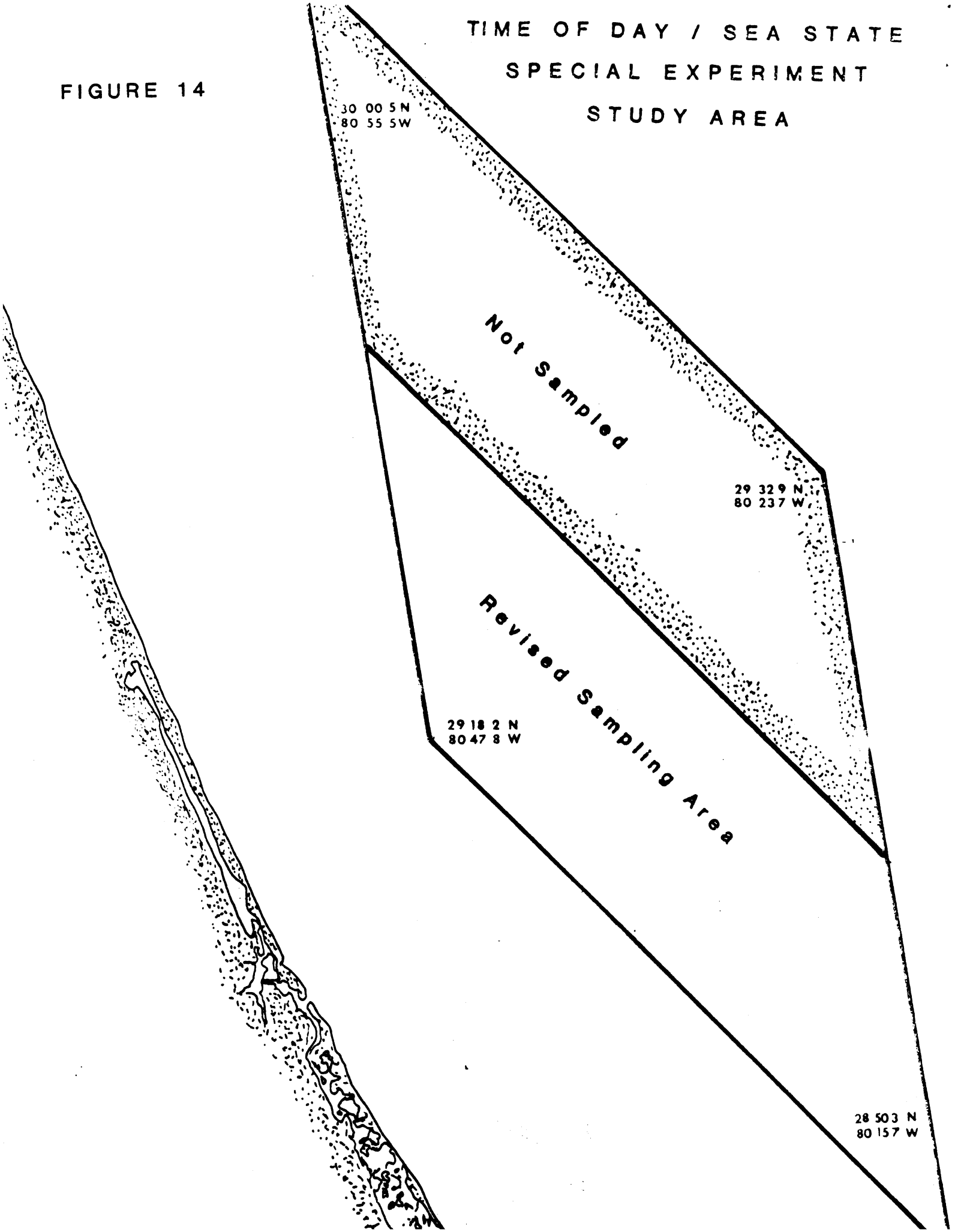


FIGURE 14


TIME OF DAY / SEA STATE
SPECIAL EXPERIMENT
STUDY AREA
30 00 5 N
80 55 5 W
Not Sampled
29 32 9 N
80 23 7 W
Revised Sampling Area
29 18 2 N
80 47 8 W
28 50 3 N
80 15 7 W

APPENDIX 1

LIST OF PARTICIPANTS

PRINCIPAL INVESTIGATOR

Dr Nancy Thompson

FLIGHT CREW

Mr John Olson, Pilot

Mr Timothy Flynn, Pilot, Co-Pilot

Mr. Paul Gilman, Co-Pilot

OBSERVERS

Mr Thomas Carr, Senior Observer

Ms Stephanie Chestnut

Mr Geoffrey LeBaron

Ms Barbara Schroeder, NMFS-SEFC Technical Representative

Aero-Marine Surveys, Inc., wishes to extend its appreciation to the personnel at Melbourne, FL FSS; Charleston, SC FSS; New Bern, NC FSS; Miami and Jacksonville ARTCC; Gateway Aviation, Titusville, FL; Hawthorne Aviation, Charleston, SC; Aeronautics Inc., Wilmington, NC; FACS FAC VA CAPES, NAS Oceana; and FACS FAC JAX, NAS Jacksonville.

APPENDIX 2. Survey Schedule as Calendars for the Four Seasonal Surveys, 1983

CALENDAR OF EVENTS

SURVEY V

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
APRIL 17	18	19	20 TRANSIT: GON TO TIX	21 BLOCK 9	22 BLOCK 7	23 WEATHER DELAY
24 WEATHER DELAY	25 ATTEMPT BLOCK 10 ABORT: HIGH SEA STATE	26 BLOCK 10	27 BLOCK 8	28 BLOCK 6	29 BLOCK 5	30 BLOCK 4
MAY 1 BLOCK 3	2 ATTEMPT BLOCK 2 LORAN STA OUT	3 WEATHER DELAY	4 WEATHER DELAY	5 BLOCK 2	6 BLOCK 1 LINES 1-18 ABORT LINES 19-27, HIGH SEA STATE	7 BLOCK 1 LINES 18-27 TRANSIT TO GON
8	9					

CALENDAR OF EVENTS SPECIAL EXPERIMENT

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				9 JUNE TRANSIT GON - TICO	10 WEATHER ABORT	11 0900-1100/2-3
12 WEATHER ABORT	13 WEATHER ABORT	14 WEATHER ABORT	15 0700-0900/2-3 0900-1100/4 1100-1300/4	16 WEATHER ABORT	17 1100-1300/2-3 1300-1500/2-3	18 1100-1300/2-3 1300-1500/2-3 1500-1700/2-3
19 0700-0900/0-1	20 0700-0900/2-3 0900-1100/2-3	21 0700-0900/2-3	22 WEATHER ABORT	23 WEATHER ABORT	24 WEATHER ABORT	25 WEATHER ABORT
26 0900-1100/0-1	27 1500-1700/4	28 1100-1300/4	29 1300-1500/2-3	30 JUNE 0900-1100/0-1 1100-1300/0-1	1 JULY 1500-1700/2-3	2 1300-1500/2-3
3JULY TRANSIT TO GON						

CALENDAR OF EVENTS

SURVEY VI

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
9 July	10	11	13	14	15	16
17 TRANSIT GON TO TIX	18 BLOCK 7	19 BLOCK 9	20 BLOCK 10	21 BLOCK 8	22 WEATHER DELAY	23 ATTEMPT BLOCK 5 ABORT, HIGH SEA STATE
24 WEATHER DELAY	25 BLOCK 5	26 WEATHER DELAY	27 ATTEMPT BLOCK 4 ABORT, HIGH SEA STATE	28 WEATHER DELAY	29 ATTEMPT BLOCK 3 ABORT, HIGH SEA STATE	30 WEATHER DELAY
31 BLOCK 4	1 AUGUST BLOCK 3	2 BLOCK 6	3 ATTEMPT BLOCK 2 ABORT, WEATHER	4 BLOCK 2	5 BLOCK 1 / TRANSIT TO GON	6

CALENDAR OF EVENTS

SURVEY VII

SUN	MON	TUE	WED	THU	FRI	SAT
OCT 30 TRANSIT: GON TO TIX	31 WEATHER DELAY	NOV 1 WEATHER DELAY	2 WEATHER DELAY	3 WEATEHR DELAY	4 AREA 8	5 AREA 9
6 AREA 10; TRANSIT: TIX TO SAV	7 ATTEMPT AREA 6/7, ABORT: HIGH SEA STATE	8 WEATHER DELAY	9 WEATHER DELAY	10 WEATHER DELAY	11 WEATHER DELAY	12 ATTEMPT AREA 6/7, ABORT: HIGH SEA STATE
13 AREA 6/7	14 AREA 4/5; TRANSIT: SAV TO ILM	15 ATTEMPT AREA 2/3, ABORT	16 TRANSIT: ILM TO GON	17		

APPENDIX 3. Tabularized Data of Sea Turtle Sightings by Species, Sampling Block and Season Four Surveys

SPRING

Southeast Turtle Survey: Turtle sightings, by species, by area. Numbers shown represent numbers of individuals.

BLOCK	C.caretta	D.coriacea	L.kempi	E.imbricata	C.Mydas	Unident Turtle	Total Turtles
1	71	1				16	88
2	96	16				17	129
3	73	8				5	86
4	123	5				8	136
5	83	3	1			7	94
6	122	1				13	136
7	79					10	89
8	248					15	263
9	132	1	1			12	146
10	59				2	18	79
TOTAL	1086	35	2		2	121	1246

Southeast Turtle Survey: Turtle sightings, by species, by area. Numbers shown represent numbers of individuals.

BLOCK	C.caretta	D.coriacea	L.kempi	E.imbricata	C.Mydas	Unident Turtle	Total Turtles
1	6						6
2	8					1	9
3	15	1				1	17
4	15					1	16
5	5						5
6	13	1				1	15
7	7					2	9
8	130	57			2	7	196
9	74	1				6	81
10	21				2	2	25
TOTAL	294	60	0	0	4	21	379

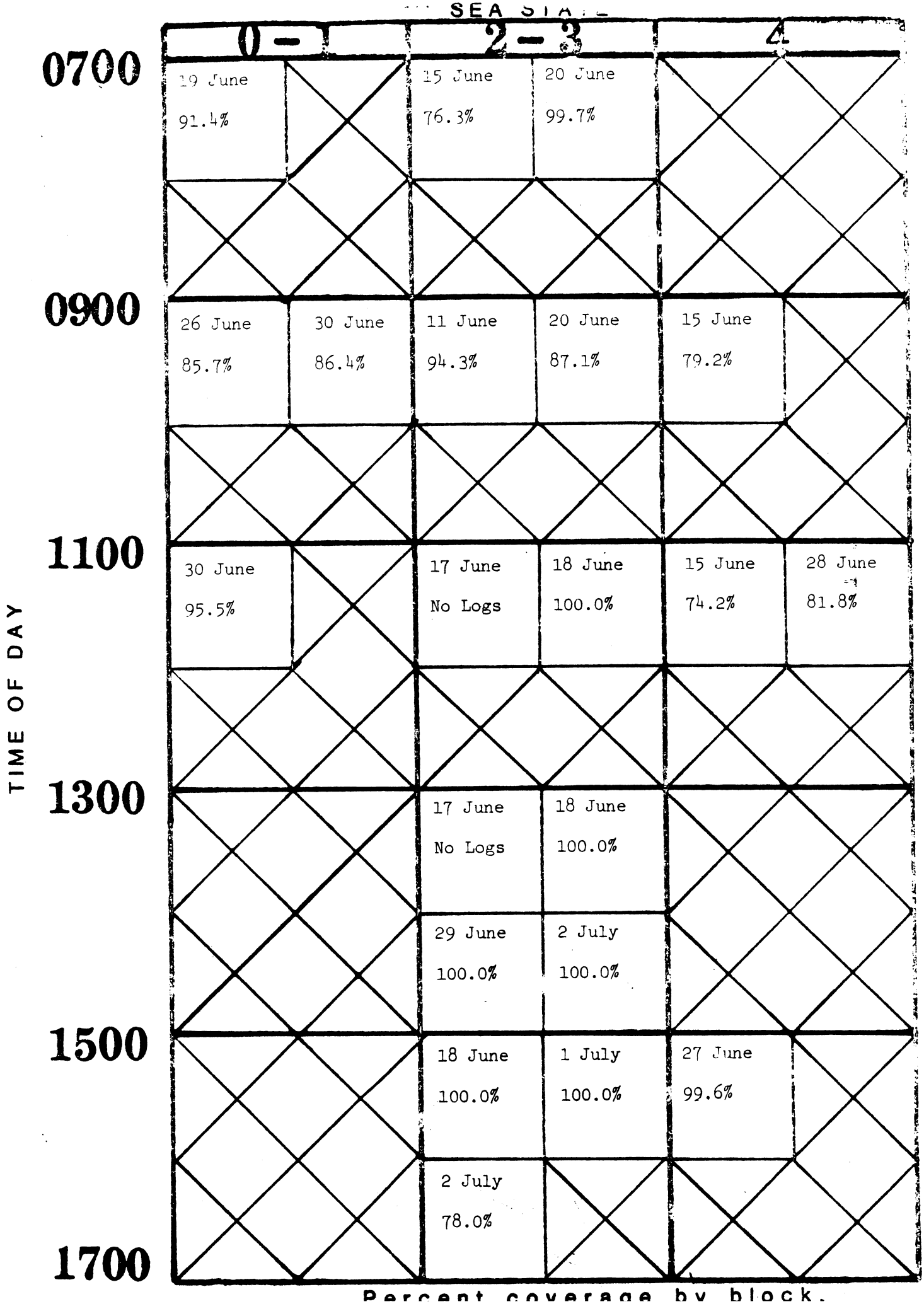
FALL/WINTER Seventh Pelagic Survey

Southeast Turtle Survey: Turtle sightings, by species, by area. Numbers shown represent numbers of individuals.

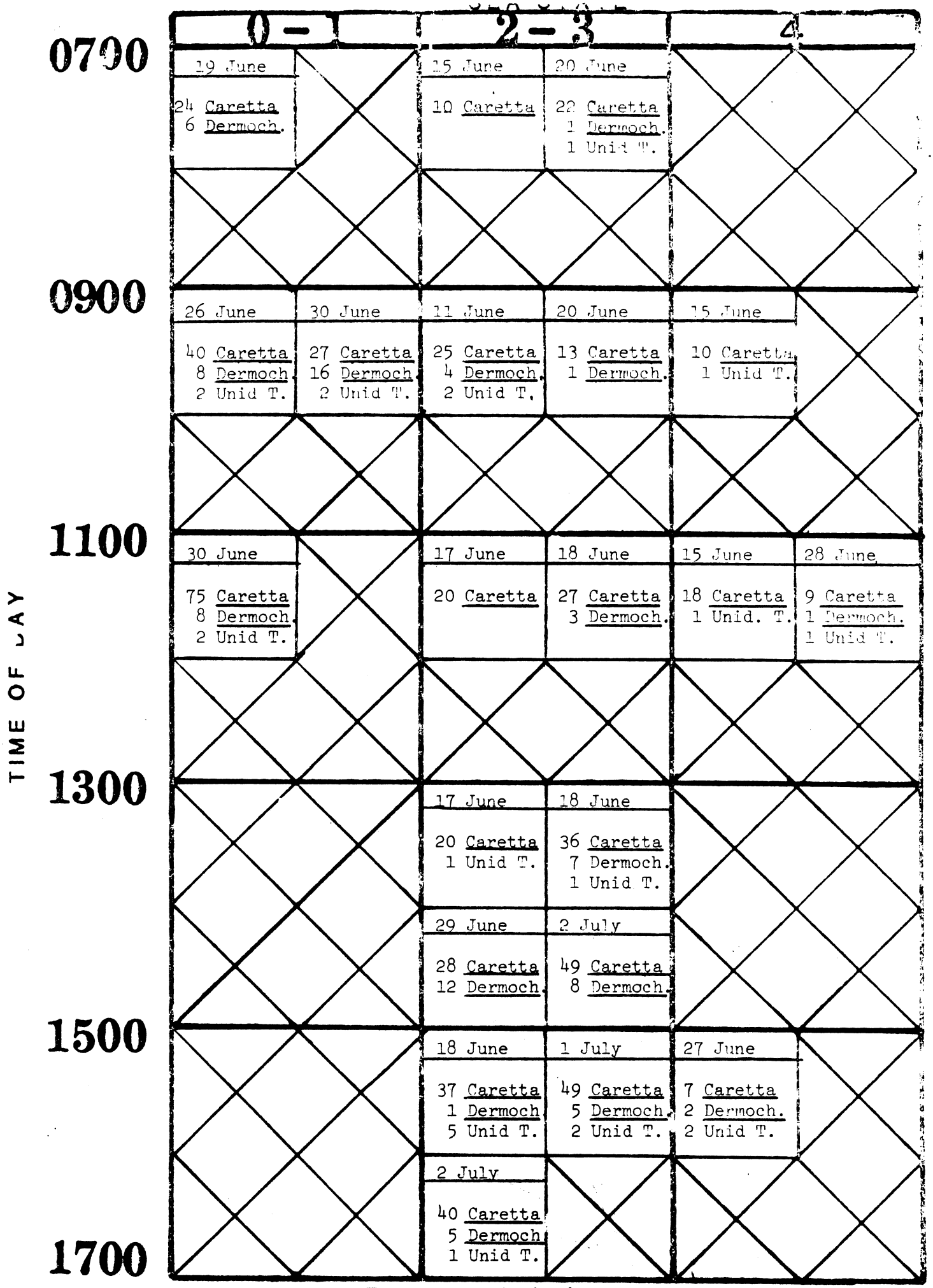
BLOCK	C.caretta	D.coriacea	L.kempi	E.imbricata	C.Mydas	Unident Turtle	Total Turtles
1 / 2 / 3							
4 / 5	28	4					32
6 / 7	12					5	17
8	10						12
9	21	1					22
10	7						7
TOTAL	78	5	0	0	0	7	90

APPENDIX 4. Sighting Data,

Sea State / Time of Day Experiment



Percent coverage by block.


0-
2-3
4
0700
0900
1100
1300
1500
1700
TIME OF DAY
19 June
24 Caretta
6 Dermoch.
15 June
10 Caretta
20 June
22 Caretta
1 Dermoch.
1 Unid T.
26 June
40 Caretta
8 Dermoch.
2 Unid T.
30 June
27 Caretta
16 Dermoch.
2 Unid T.
11 June
25 Caretta
4 Dermoch.
2 Unid T.
20 June
13 Caretta
1 Dermoch.
15 June
10 Caretta
1 Unid T.
30 June
75 Caretta
8 Dermoch.
2 Unid T.
17 June
20 Caretta
18 June
27 Caretta
3 Dermoch.
15 June
18 Caretta
1 Unid. T.
28 June
9 Caretta
1 Dermoch.
1 Unid T.
17 June
20 Caretta
1 Unid T.
18 June
36 Caretta
7 Dermoch.
1 Unid T.
29 June
28 Caretta
12 Dermoch.
2 July
49 Caretta
8 Dermoch.
18 June
37 Caretta
1 Dermoch
5 Unid T.
1 July
49 Caretta
5 Dermoch.
2 Unid T.
27 June
7 Caretta
2 Dermoch.
2 Unid T.
2 July
40 Caretta
5 Dermoch
1 Unid T.

SEA STATE

TIME OF DAY

	0-	2-3		4	
0700	19 June 15 Tursiops 10 Unid.MM	15 June 5 Tursiops	20 June 18 Tursiops 5 Unid MM		
0900	26 June 29 Tursiops	30 June 20 Tursiops 2 Unid MM	11 June 75+/-12 Tursiops	20 June 12 Tursiops	15 June
1100	30 June 92+/-10 Tursiops		17 June 38+/-5 Tursiops 2 Unid MM	18 June 25 Tursiops	15 June 4 Tursiops 28 June
1300			17 June 3 Unid MM	18 June 15 Tursiops	
			29 June 41+/-4 Tursiops 21+/-4 Unid MM	2 July 41 Tursiops 4 Unid MM	
1500			18 June 22+/-2 Tursiops	1 July 13 Tursiops 1 Unid MM	27 June 2 Tursiops
1700			2 July 2 Tursiops 7 Unid MM		

Marine mammal sightings

APPENDIX 5. Tabularized Data on Marine Mammal Sightings by Species, Sampling Block and Season.

Southeast Turtle Survey; Marine mammal sightings, by species, by area. Numbers represent individuals sighted.

BLOCK	T.truncatus	Stenella spp	Unident Dolphin	B.glacialis	Unident Mar Mam	Total Mar Mam
1	31	12				43
2	108+/-15	4	5			117+/-15
3	153+/- 7		28	2	1	184+/- 7
4	66+/- 2		11+/- 2			77+/- 4
5	156+/-12		9+/- 2			165+/-14
6	283+/-28	15+/-2	26			324+/-30
7	74+/- 7		25			99+/- 7
8	171+/-14					171+/-14
9	72+/-12	50+/-10	2			124+/-22
10	37				1	38
TOTAL	1151+/-97	81+/-2	106+/- 4	2	2	1342+/-113

Southeast Turtle Survey; Marine mammal sightings, by species, by area. Numbers represent individuals sighted.

BLOCK	T.truncatus	Stenella spp	Stenella Plagiodon	Unident Dolphin	Unident Mar Mam	Total Mar Mam
1	7		12+/- 3	28		47+/- 3
2	10	3		1		14
3	24+/- 1			20+/- 4		44+/- 5
4	5		9+/- 2	13+/- 2		27+/- 4
5	4					4
6	52+/- 7	4		18		74+/- 7
7	67					67
8	99+/- 2	7	67+/-7	31		204+/- 9
9	15			1		16
10	8			3	1	12
TOTAL	291+/-10	14	88+/-12	115+/- 6	1	509+/- 28

Southeast Turtle Survey; Marine mammal sightings, by species, by area. Numbers represent individuals sighted.

BLOCK	T.truncatus	Stenella spp	Stenella plagiodon	Unident Dolphin	Unident Mar Mam	Total Mar Mam
1 / 2 / 3						
4 / 5	63		15	8		86
6 / 7	28	1		2		28
8	77					77
9	2					2
10	6					6
TOTAL	176	1	15	10	0	202